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Aggregate Resources Inventory of Derby Township

Grey County
Southern Ontario

By Staff of the Engineering and Terrain Geology Section, Ontario Geological Survey

1985

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Minister

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Every possible effort is made to ensure the accuracy of the information contained in this report, but the Ministry of Natural Resources does not assume any liability for errors that may occur. Source references are included in the report and users may wish to verify critical information.

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Aggregate Resources Inventory of Derby Township Grey County

by
Staff[1] of the Engineering and Terrain Geology Section

1. Project supervisor: Dale W. Scott; field work and report by G. Jones; compilation and drafting by staff of the Aggregate Assessment Office. The Mineral Resources Staff of Owen Sound District and Southwestern Region of the Ministry of Natural Resources assisted in the collection of data, field checking and review of this report.

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Abstract

This report includes both an inventory and evaluation of sand and gravel, as well as bedrock resources, in Derby Township. The report is part of the Aggregate Resources Inventory Program for townships and municipalities designated under the Pits and Quarries Control Act.

In Derby Township, three areas containing significant amounts of sand and gravel have been selected for possible resource protection. Selected Sand and Gravel Resource Areas occupy 3450 acres (1400 ha), exclusive of licenced properties. An estimated 2750 acres (1110 ha) are currently available for extraction, containing resources of approximately 155 million tons (141 million tonnes). The parts of the selected areas which are available for extraction represent 27 percent of the total area occupied by sand and gravel deposits in the township and 34 percent of the original resource tonnage.

Selected Sand and Gravel Resource Area 1 consists of three glacial deposits situated in the southeastern part of the township. The four deposits of Resource Area 2 and the isolated ice-contact deposit of Resource Area 3 are located in the southwest. Granular material of varying quality is exposed in these resource areas which are suitable for the extraction of a variety of aggregate products.

Several deposits have also been selected at the secondary level in the township. Although these deposits are generally not as significant as the Primary Selected Areas, they add considerably to the township's resource base.

Generally, the township has sand and gravel resources which should be able to supply local needs for a considerable period of time. However, resources of high-quality aggregate suitable for hot-laid asphaltic and concrete uses are considered limited. Care should be taken to ensure the continuing availability of as much of these resources as possible.

Bedrock underlying Derby Township consists of the Queenston, Manitoulin, Cabot Head, Fossil Hill, Amabel and Guelph Formations. Of these formations, the Amabel is considered the best suited for extractive development as a wide variety of products can be produced from the usually high-quality dolostone of this unit. One area, predominantly consisting of Amabel bedrock, has been selected for possible resource protection. The area has an estimated 8200 acres (3300 ha) currently available for extraction and contains possible resources of 1770 million tons (1610 million tonnes).

Selected Resource Areas are not intended to be permanent, single land use units which must be incorporated in an official planning document. They represent areas in which a major resource is known to exist. Such Resource Areas may be reserved wholly or partially for extractive development and/or resource protection within the context of the official plan.

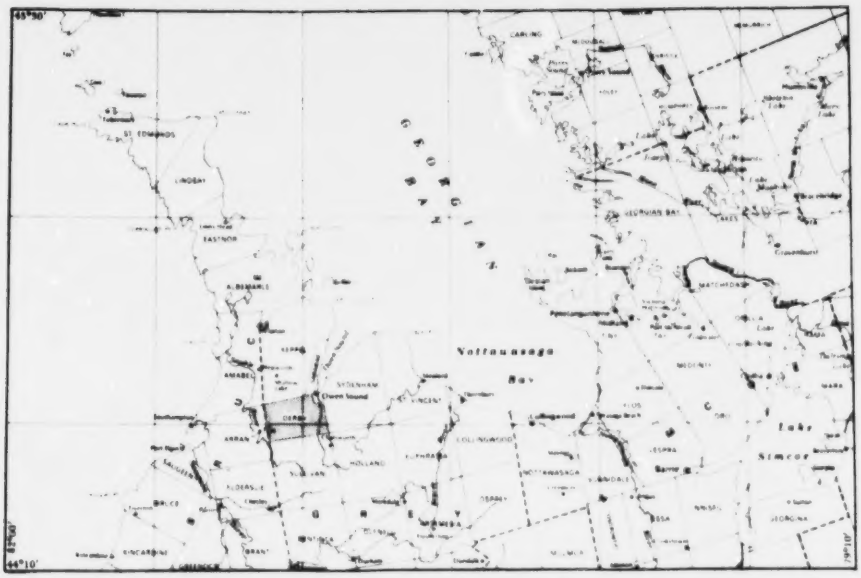


Figure 1. Key Map Showing the Location of Derby Township, Scale 1:1 800 000.

Introduction

Mineral aggregates, which include bedrock-derived crushed stone as well as naturally formed sand and gravel, constitute the major raw material in Ontario's road-building and construction industries. Very large amounts of these materials are used each year throughout the Province. For example, in 1982, the total tonnage of mineral aggregates extracted was 101 million tons (92 million tonnes), greater than that of any other metallic or nonmetallic commodity mined in the Province (Ontario Ministry of Natural Resources 1983).

Although mineral aggregate deposits are plentiful in Ontario, they are fixed-location, nonrenewable resources which can be exploited only in those areas where they occur. Mineral aggregates are characterized by their high bulk and low unit value so that the economic value of a deposit is a function of its proximity to a market area as well as its quality and size. The potential for extractive development is usually greatest in urban fringe areas where land use competition is extreme. For these reasons the availability of adequate resources for future development is now being threatened in some areas.

Comprehensive planning and resource management strategies are required to make the best use of available resources, especially in those areas experiencing rapid development. Such strategies must be based on a sound knowledge of the total mineral aggregate resource base at both local and regional levels. The purpose of the Aggregate Resources Inventory is to provide the basic geological information required to include potential mineral aggregate resource areas in planning strategies and official plans. The reports should form the basis for discussion on those areas best suited for possible extraction. The aim is to assist decision-makers in protecting the public well-being by ensuring that adequate resources of mineral aggregate remain available for future use.

This report is a technical background document, based for the most part on geological information and interpretation. It has been designed as a component of the total planning process and should be used in conjunction with other planning considerations, to ensure the best use of a municipality's resources.

The report includes an assessment of sand and gravel resources as well as a discussion on the potential of bedrock-derived aggregate. The most recent information available has been used to prepare the report. As new information becomes available, revisions may be necessary.

Part I — Inventory Methods

FIELD AND OFFICE METHODS

The methods used to prepare the report primarily involve the interpretation of published geological data such as bedrock and surficial geology maps and reports (see References) as well as field examination of potential resource areas. Field methods include the examination of natural and man-made exposures of granular material. Most observations are made at quarries and sand and gravel pits located from records held by the Ontario Ministry of Transportation and Communications, the Ontario Geological Survey, and by Regional and District Offices of the Ontario Ministry of Natural Resources. Observations made at pit sites include estimates of the total face height and the proportion of gravel- and sand-sized fragments in the deposit. Observations are also made of the shape and lithology of the particles. These characteristics are important in estimating the quality and quantity of the aggregate. In areas of limited exposure, test pitting, soil probing, hand augering and geophysical techniques are used to assess subsurface materials. Airphotos at various scales are used to determine the continuity of deposits, especially in areas where information is limited.

Deposits with potential for further extractive development or those where existing data are scarce, are studied in greater detail. Representative layers in these deposits are sampled in 25- to 100- pound (11 to 45 kg) units from existing pit faces or from test pits. The samples are analysed for grain size distribution and in some cases Los Angeles abrasion, absorption, and Magnesium Sulphate soundness tests along with petrographic analyses are performed.

Analyses are performed either in the laboratories of the Soils and Aggregates Section, Engineering Materials Office, Ontario Ministry of Transportation and Communications, or in the Geoscience Laboratories, Geoservices Section, Ontario Geological Survey. In areas of limited subsurface exposure, test holes are drilled and geophysical surveys using hammer seismic equipment are undertaken. The symbols for and locations of sample and test hole sites along with geophysical traverse lines are noted on Map 1.

In the office, the field data are supplemented by pit information on file with the Soils and Aggregates Section of the Ontario Ministry of Transportation and Communications. Data contained in these files include field estimates of the depth, composition and "workability" of deposits as well as laboratory analyses of the physical properties and chemical suitability of the aggregate. Information concerning the development history of the pits and acceptable uses of the aggregate is also recorded. The location, size, and depth of extraction of pits licenced under the Pits and Quarries Control Act are obtained from records held by Regional and District Offices of the Ontario Ministry of Natural Resources. The cooperation of the above-named groups in the compilation of inventory data is gratefully acknowledged.

Water well records, held by the Ontario Ministry of the Environment, are used in some areas to corroborate thickness estimates or to indicate the presence of buried granular material. These records are used in conjunction with other evidence. Topographic maps of the National Topographic System, at a scale of 1:50 000, were used as a compilation base for the field and office data. The information was then transferred to a base map, also at a scale of 1:50 000, prepared by the Cartography Section of the Lands and Waters Group, Ontario Ministry of Natural Resources, for presentation in the report.

RESOURCE TONNAGE CALCULATION TECHNIQUES

SAND AND GRAVEL RESOURCES

Once the interpretative boundaries of the aggregate units have been drawn, quantitative estimates of the possible resources available can be made. Generally, the volume of a deposit can be calculated if its areal extent and average thickness are known or can be estimated. The computation methods used are as follows. First, the area of the deposit, as outlined on the final base map, is calculated in acres. The thickness values used are an approximation of the deposit thickness, based on the face heights of pits developed in the deposit or on subsurface data such as test holes and water well logs. Original tonnage values can then be calculated by multiplying the volume of the deposit by 2500 (the density factor). This factor is approximately the number of tons in a one-foot (0.3 m) thick layer of sand and gravel, one acre (0.4 ha) extent, assuming an average density of 110 pounds per cubic foot (1766 kg per cubic metre).

Tonnage = Area x Thickness x Density Factor

Tonnage calculated in this manner must be considered only as an estimate. Furthermore, such tonnages represent amounts that existed prior to any extraction of material (i.e. original tonnage) (Table 1, Column 4).

The Selected Sand and Gravel Resource Areas in Table 3 are calculated in the following way. Two successive subtractions are made from the total area. Column 3 accounts for the number of acres unavailable because of the presence of permanent cultural features and their associated setback requirements. Column 4 accounts for those areas that have previously been extracted (e.g. wayside and abandoned pits are included in this category). The remaining figure is the area of the deposit currently available for extraction (Column 5). The available area is then multiplied by the estimated deposit thickness and the density factor (Column 5 x Column 6 x 2500) to give an estimate of the sand and gravel tonnage (Column 7) presently available for extractive development and/or resource protection.

Reserve estimates are calculated for deposits of primary significance. Reserve estimates for deposits of secondary and tertiary significance are not calculated in Table 3, however the aggregate potential of these deposits is discussed in the report.

BEDROCK RESOURCES

The method used to calculate resources of bedrock-derived aggregate is much the same as that described above. The areal extent of bedrock formations overlain by less than 50 feet (15 m) of unconsolidated overburden is determined from bedrock geology maps, drift thickness and bedrock topography maps, and from the interpretation of water well records. The

measured extent of such areas is then multiplied by the estimated quarriable thickness of the formation, based on stratigraphic analyses and on estimates of existing quarry faces in the unit. In some cases a standardized estimate of 60 feet (18 m) is used for thickness. Volume estimates are then multiplied by the density factor (the estimated weight in tons of a one-foot (0. 3 m) thick section of rock, one acre (0.4 ha) in extent).

Resources of dolostone are calculated using a density factor of 165 pounds per cubic foot (2649 kg per cubic metre) or 3600 tons per acre (8070 tonnes per hectare). Sandstone resources are calculated using a density estimate of 146 pounds per cubic foot (2344 kg per cubic metre) and shale resources are calculated with a factor of 150 pounds per cubic foot (2408 kg per cubic metre).

UNITS AND DEFINITIONS

Although most of the measurements and other primary data available for resource tonnage calculations are given in Imperial units. Metric units have also been given in the text and on the tables which accompany the report. The Metric equivalent of the data is shown in brackets after or directly below the corresponding Imperial figures. Data are generally rounded off in accordance with the Ontario Metric Practice Guide (Metric Committee 1975).

The tonnage estimates made for sand and gravel deposits are termed possible resources in accordance with terminology of the Ontario Resource Classification Scheme (Robertson 1975, p.7) and with the Association of Professional Engineers of Ontario (1976) (see Glossary, Appendix B).

Part II — Data Presentation and Interpretation

Three maps, each portraying a different aspect of the aggregate resources in the municipality, accompany the report. Map 1, "Distribution of Sand and Gravel Deposits", gives a comprehensive inventory of the sand and gravel resources in the report area. Map 2, "Selected Sand and Gravel Resource Areas", shows those deposits which are considered to represent the largest and/or highest quality resources in the area. Map 3, "Bedrock Resources" shows the distribution of bedrock formations, the thickness of overlying unconsolidated sediments, and identifies the Selected Bedrock Resource Areas.

MAP 1: DISTRIBUTION OF SAND AND GRAVEL DEPOSITS

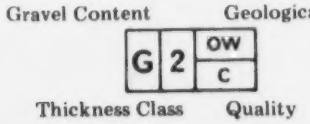
Map 1 is derived from existing surficial geology maps of the area or from airphoto interpretation in areas where surficial mapping is incomplete. The map shows the extent and quality of sand and gravel deposits within the study area and the present level of extractive activity.

On the map, gravel deposits are indicated by dark brown shading while sand deposits are shaded light brown. The present level of extractive activity is also indicated. Those areas which are licenced for extraction under the Pits and Quarries Control Act are shown by a solid outline and identified by a number which refers to the pit descriptions in Table 2. Each description notes the owner, location and licenced acreage of the pit, as well as the estimated face height and percentage gravel. A number of unlicenced pits (abandoned pits or wayside pits operating on demand under authority of a permit) are identified by a numbered dot on Map 1 and described in Table 2.

Map 1 also presents a summary of available information related to the quality of aggregate contained in all the known aggregate deposits in the study area. Much of this information is contained in the symbols which are found on the map. The Deposit Symbol appears for each mapped deposit and summarizes important genetic and textural data. The Texture Symbol is a circular proportional diagram which displays the grain size distribution of the aggregate in areas where bulk samples were taken.

DEPOSIT SYMBOL

The Deposit Symbol is similar to those used in soil mapping and land classification systems commonly in use in North America. The components of the symbol indicate the gravel content, thickness of material, origin (type), and quality limitations for every deposit shown on Map 1. These components are illustrated by the following example:



This symbol identifies an outwash deposit 10 to 20 feet (3 to 6 m) thick containing more than 35 percent gravel. Excess silt and clay may limit uses of the aggregate in the deposit.

The "gravel content" and "thickness class" are basic criteria for distinguishing different deposits. The "gravel content" symbol is an upper case "S" or "G". The "S" indicates that the deposit is generally "sandy" and that gravel-sized aggregate (greater than 4.75 mm) makes up less than 35 percent of the whole deposit. "G" indicates that the deposit contains more than 35 percent gravel.

The "thickness class" indicates a depth range which is related to the potential resource tonnage for each deposit. Four thickness class divisions have been established as shown in the legend for Map 1.

Two smaller sets of letters, divided from each other by a horizontal line, follow the thickness class number. The upper series of letters identifies the geologic deposit type (the types are summarized with respect to their main geologic and extractive characteristics in Appendix C) and the lower series of letters identifies the main quality limitations that may be present in the deposit as discussed in the next section.

TEXTURE SYMBOL

The Texture Symbol provides a more detailed assessment of the grain size distribution in deposits where samples were taken for analysis during field study. The information from which these symbols are derived has been plotted in grain size distribution graphs. The relative amounts of gravel, sand, and silt and clay in the sampled material are shown graphically by the subdivision of a circle into proportional segments. The following example shows a hypothetical sample consisting of 30 percent gravel, 60 percent sand, and 10 percent silt and clay:

Test hole locations are shown on Map 1 by a solid drill hole symbol. Geophysics lines are shown on the map by a line symbol.

MAP 2: SELECTED SAND AND GRAVEL RESOURCE AREAS

Map 2 is an interpretative map derived from an evaluation of the deposits shown on Map 1. The deposits identified on Map 2 are those which are considered to be important in ensuring an adequate resource base for the future.

All the selected sand and gravel resource areas are first delineated by geological boundaries and then classified into three levels of significance: primary; secondary; and tertiary. Each area of primary significance is assessed as to its probable relative value as a resource in the municipality and is given a deposit number which denotes its ranking order. All such deposits are shown by dark shading on Map 2.

Deposits of secondary significance are not ranked numerically in this report, but are indicated by light red shading on Map 2. Such deposits are believed to contain significant amounts of sand and gravel. Al-

though deposits of secondary significance are not considered to be the "best" resources in the report area, they may contain large quanitities of sand and gravel and should be considered as part of the aggregate supply of the area.

Areas of tertiary significance are outlined on the map by a solid line but have no shading. They are not considered to be important resource areas because of their low available resources, or because of possible difficulties in extraction. Such areas may be useful for local needs but are unlikely to support large-scale development.

Selected Sand and Gravel Resource Areas of primary significance are not permanent, single, land use units which must be incorporated in an official planning document. They represent areas in which a major resource is known to exist. Such Resource Areas may be reserved wholly or partially for extractive development and/or resource protection within the context of the official plan.

The process by which deposits are evaluated and selected involves the consideration of two sets of criteria. The main selection criteria are site specific, related to the characteristics of individual deposits. Factors such as deposit size, aggregate quality, and deposit location and setting are considered in the selection of those deposits best suited for extractive development. A second set of criteria involves the assessment of local aggregate resources in relation to the quality, quantity, and distribution of resources in the region in which the report area is located. The intent of such a process of evaluation is to ensure the continuing availability of sufficient resources to meet possible future demands.

SITE SPECIFIC CRITERIA

Deposit Size

Ideally, selected deposits should contain available sand and gravel resources large enough to support a commercial pit operation using a stationary or portable processing plant. In practice, much smaller deposits may be of significant value depending on the overall reserves in the rest of the municipality. Generally, deposits in Class 1, i.e. those thicker than 20 feet (6 m), and containing more than 35 percent gravel are considered to be most favourable for commercial development. Thinner deposits may be valuable in municipalities with low total resources.

Aggregate Quality

The limitations of natural aggregates for various uses result from variations in the litholgy of the particles composing the deposit, and from variations in the size distribution of these particles.

Four indicators of the quality of aggregate may be included in the symbol for each deposit on Map 1. They are: gravel content (G or S); fines (C); oversize (O); and lithology (L).

Three of the indicators deal with grain size distribution. The gravel content (G or S) indicates the suitability of aggregate for various uses. Deposits containing at least 35 percent gravel in addition to a minimum of 20 percent material greater than the 26.5 mm sieve are considered to be the most favourable extractive sites, since this content is the minimum from which crushed products can be economically produced.

Excess fines (high silt and clay content) may severely limit the potential use of a deposit. Fines content in excess of 10 percent may impede drainage in road sub-base aggregate and render it more susceptible to the effects of frost action. In asphalt aggregate, excess fines hinder the bonding of particles. Deposits known to have a high fines content are indicated by a "C" in the quality portion of the Deposit Symbol.

Deposits containing more than 20 percent oversize material (greater than 4 inches (10 cm) in diameter) may also have use limitations. The oversize component is unacceptable for all concrete aggregate and for road-building aggregate, so it must be either crushed or removed during processing. Deposits known to have an appreciable oversize component are indicated by an "O" in the quality portion of the Deposit Symbol.

The other indicator of the quality of an aggregate is lithology. Just as the unique physical and chemical properties of bedrock types determine their value for use as crushed rock, so do various lithologies of particles in a sand and gravel deposit determine its suitability for various uses. The presence of objectionable lithologies such as chert, siltstone, and shale, even in relatively small amounts, can result in a reduction in the quality of an aggregate, especially for high quality uses such as concrete and asphalt. Similarly, highly weathered, very porous and friable rock can restrict the quality of an aggregate. Deposits known to contain objectionable lithologies are indicated by an "L" in the quality component of the Deposit Symbol.

If the Deposit Symbol indicates either "C", "O", or "L" or any combination, the quality of the deposit is considered to be reduced for some uses of the aggregate. No attempt has been made to quantify the degree of limitation imposed. Assessment of the four indicators is made from published data, from data contained in files of both the Ontario Ministry of Transportation and Communications and the Engineering and Terrain Geology Section of the Ontario Geological Survey, and from field observations.

Analyses of unprocessed samples obtained from test holes, pits or sample sites have been plotted on grain size distribution graphs. On the graphs are the gradation specification envelopes for Ontario Ministry of Transportation and Communications' products: Granular Base Course A, B and C; Hot-Laid Asphaltic Sand Nos. 1,2,3,4, and 8; and concrete sand. By plotting the gradation curves with respect to the specification envelopes, it can be determined how well the unprocessed sampled material meets the criteria for each product.

Location and Setting

The location and setting of a resource area has a direct influence on its value for possible extraction. The evaluation of a deposit's setting is made on the basis of natural and man-made features which may limit or prohibit extractive development.

First, the physical context of the deposit is considered. Deposits with some physical constraint on ex-

tractive development, such as thick overburden or high water table, are less valuable resource areas because of the difficulties involved in resource recovery. Second, permanent man-made features, such as roads, railways, powerlines, and housing developments, which are built on a deposit, may prohibit its extraction. The constraining effect of legally required setbacks surrounding such features is included in the evaluation. A quantitative assessment of these constraints can be made by measurement of their areal extent directly from the topographic maps. The area rendered unavailable by these features is shown for each resource area in Table 3 (Column 3).

The assessment of sand and gravel deposits with respect to local land use and to private land ownership is an important component of the general evaluation process. These aspects of the evaluation process are not considered further in this report, but readers are encouraged to discuss them with personnel of the pertinent District Office of the Ontario Ministry of Natural Resources.

REGIONAL CONSIDERATIONS

In selecting sufficient areas for resource development, it is important to assess both the local and the regional resource base, and to forecast future production and demand patterns.

Some appreciation of future aggregate requirements in an area may be gained by assessing its present production levels and by forecasting future production trends. Such an approach is based on the assumptions that production levels in an area closely reflect the demand and that the present production "market share" of an area will remain roughly at the same level.

The aggregate resources in the region surrounding a municipality should be assessed in order to properly evaluate specific resource areas and to adopt optimum resource management plans. For example, a municipality that has large resources in comparison to its surrounding region constitutes a regionally significant resource area. Municipalites with high resources in proximity to large demand centres, such as metropolitan areas, are special cases.

Although an appreciation of the regional context is required to develop comprehensive resource management techniques, such detailed evaluation is beyond the scope of this report. The selection of resource areas made in this study is based primarily on geological data or on considerations outlined in preceding sections.

MAP 3: BEDROCK RESOURCES

Map 3 is an interpretative map derived from bedrock geology, drift thickness and bedrock topography maps, water well data from the Ontario Ministry of the Environment, oil and gas well data from the Petroleum Resources Section (Ontario Ministry of Natural Resources) and from geotechnical test hole data from various sources. Map 3 is based on concepts similar to those outlined for Maps 1 and 2, but displays both the inventory and evaluation on the one map.

The geological boundaries of the bedrock units are shown by a dashed line. Isolated outcrops are indicated by an "X". Three sets of contour lines delineate areas of less than 3 feet (1 m) of drift, areas of 3 to 25 feet (1 to 8 m) of drift, and areas of 25 to 50 feet (8 to 15 m) of drift. The extent of these areas of thin drift are shown by three shades of blue. The darkest shade indicates where bedrock outcrops or is within 3 feet (1 m) of the ground surface. These areas consitute potential resource areas because of their easy access. The medium shade indicates areas where drift cover is up to 25 feet (8 m) thick. Quarrying is possible in this depth of overburden and these zones also represent potential resource ares. The lightest shade indicates bedrock areas overlain by 25 to 50 feet (8 to 15 m) of overburden. These latter areas constitute resources which have extractive value only in specific circumstances. Outside of these delineated areas, the bedrock can be assumed to be covered by more than 50 feet (15 m) of overburden, a depth generally considered to be too great to allow economic extraction (unless part of the overburden is composed of economically attractive deposits).

Other inventory information presented on Map 3 is designed to give an indication of the present level of extractive activity in the report area. Those areas which are licenced for extraction under the Pits and Quarries Control Act are shown by a solid outline and identified by a number which refers to the quarry descriptions in Table 5. Each description notes the owner, location, licenced acreage and an estimate of face height. Unlicenced quarries (abandoned quarries or wayside quarries operating on demand under authority of a permit) are also identified and numbered on Map 3 and described in Table 5. One additional symbol appears on the map: an open dot indicates the location of a selected drill hole which penetrates bedrock. The overburden thickness is shown in feet beside the open dot.

SELECTION CRITERIA

Criteria equivalent to those used for sand and gravel deposits are used to select bedrock areas most favourable for extractive development.

The evaluation of bedrock resources is made primarily on the basis of performance and suitability data established by laboratory testing at the Ontario Ministry of Transportation and Communications. The main characteristics and uses of the bedrock units found in southern Ontario are summarized in Appendix D.

Deposit "size" is related directly to the areal extent of thin drift cover overlying favourable bedrock formations. Since vertical and lateral variations in bedrock units are much more gradual than in sand and gravel deposits, the quality and quantity of the resource are usually consistent over large areas.

Quality of the aggregate derived from specific bedrock units is established by the performance standards previously mentioned. Location and setting criteria and regional considerations are identical to those for sand and gravel deposits.

SELECTED RESOURCE AREAS

Selection of Bedrock Resource Areas has been restricted to a single level of significance. Three factors support this approch. First, quality and quantity variations are gradual. Second, the areal extent of a given quarry operation is much smaller than that of a sand and gravel pit producing an equivalent tonnage of material, and third, since crushed bedrock has a higher unit value than sand and gravel, longer haul distances can be considered. These factors allow the identification of alternative sites having similar development potential. The Selected Areas, if present, are shown on Map 3 by a line pattern and the calculated available tonnages are given in Table 6.

Selected Bedrock Resource Areas shown on Map 3 are not permanent, single land use units which must be incorporated in an official planning document. They represent areas in which a major bedrock resource is known to exist. Such Resource Areas may be reserved wholly or partially for extractive development and/or resource protection within the context of the official plan.

Part III — Assessment of Aggregate Resources in Derby Township

LOCATION AND POPULATION

Derby Township occupies an area of 41,369 acres (16 742 ha) in the northwestern part of Grey County. The township is shown on parts of the Owen Sound (41 A/10), Markdale (41 A/7), Chesley (41 A/6) and Wiarton (41 A/11) map sheets of the National Topographic System at a scale of 1:50 000.

The population of the township was 2453 in 1982, an increase of approximately 6 percent since 1972 (Ontario Ministry of Muncipal Affairs and Housing 1983; Ontario Ministry of Treasury, Economics and Intergovernmental Affairs 1974). The majority of the residents in the township are engaged in farming or are rural-residential inhabitants. Bordering the northeastern corner of Derby Township is the City of Owen Sound which is a major population centre (pop. 19 624 in 1982) in the area.

Access within the township is provided by gravel-surfaced township roads, paved county roads and King's Highways 6-10, 6-21 and 70, all of which form a well developed grid pattern. The township is also served by a line of the Canadian Pacific Railway which runs north- south just outside its eastern boundary. The City of Owen Sound is situated along an arm of Georgian Bay, the deep waters of which provide an additional means of transportation into the area.

PHYSIOGRAPHY AND SURFICIAL GEOLOGY

The physiography and distribution of unconsolidated sediments, including sand and gravel deposits, are the result of glacial activity which took place during the Late Wisconsinan Substage of the Pleistocene Epoch, informally known as the 'Great Ice Age'. This substage, which lasted from approximately 23 000 to 10 000 years ago, was marked by the repeated advance and melting back of massive, continental ice sheets.

A stony sandy silt till was deposited over large areas in the township by ice which advanced from the northeast (Sharpe and Edwards 1979; Sharpe and Jamieson 1982). This till is the major constituent of several drumlins and a considerable proportion of the township has been included in the physiographic region referred to as the Arran Drumlin Field (Chapman and Putnam 1966). Another till, a clayey silt till, occurs locally in a series of thin moraines which trend in a general east-west direction across the township (Sharpe and Edwards 1979; Sharpe and Jamieson 1982). These moraines, known as the Tara Moraines, were probably formed during temporary halts of the retreating ice sheet. The moraines can consist of predominantly till or of ice-contact stratified drift with minor amounts of till. Ice- contact stratified drift is common in parts of several of the moraines that traverse the township. This morainic ice-contact material was probably deposited in a variety of environments which include deltaic, kame and esker origins. This material has been a traditional source of aggregate in the township.

Between the moraines there exists a variety of glacial features including esker, ice-contact deltaic, kame, ice-contact and outwash deposits. The eskers trend in a general north-south direction between the moraines. They were deposited by meltwaters flowing under the ice or in re-entrants in the ice and are often associated with ice-contact deltas and kames. The deltas were deposited as meltwaters flowed, near the ice margin, into glacial lakes which formed as the ice retreated. Kames are hummocky features, possibly deposited by meltwaters in depressions or fissures on the ice surface or at its margin. The origin of the ice-contact deposits is similar to that of the moraines and can be attributed to a variety of depositional environments. The outwash features, on the other hand, were deposited by glacial meltwaters flowing beyond the ice margin. All these features are predominantly made up of stratified sand and gravel and several of these deposits have been extensively used as aggregate sources. Leyland (1979) has previously described, in detail, two esker and associated deposits in the southeastern part of the township.

As the ice margin retreated northeastward above the Niagara Escarpment, glaciolacustrine sediments were deposited in the low- lying areas of the township. The patchy character of this glaciolacustrine cover possibly reflects the short-lived nature of these lakes (Sharpe and Edwards 1979). Subsequent retreat of the ice margin away from the escarpment into Georgian Bay resulted in the impoundment of glacial waters between the ice sheet and the Niagara Escarpment. The lacustrine sediments deposited in these lakes, below the escarpment, reflect the continual lowering of water levels as the ice retreated further from the area. Initial high water levels are represented by a localized lacustrine beach deposit situated east of Springmount on a wave-modified drumlin (Feenstra, in prep.). This beach deposit is too restricted in extent to be shown on Map 1. Progressively lower water levels in the lakes are represented by Lake Algonquin and Lake Nipissing lacustrine sediments (Feenstra, in prep.). There are basically two types of lacustrine sediments deposited in the township. In the deep waters of the lakes, silt and clay were deposited, while predominantly silty fine sand was deposited in the shallower parts. The silt and clay are unsuitable for aggregate use and the sand is usually too fine for most road-building and construction products.

Postglacial erosional and depositional processes have been of relatively minor importance in modifying the physiography of the township. Alluvial sediments are present along the banks of the Sydenham and Pottawatomi Rivers at several locations. Poor drainage in several depressions has led to the development of a number of marshes within the township.

EXTRACTIVE ACTIVITY

Numerous sand and gravel pits have been identified in Derby Township. At the time of writing, twenty-one pits were licenced to operate with a total area of 1261.8 acres (510.6 ha). Since the designation of Derby Township in 1972 under the Pits and Quarries Control Act records of the total annual production of sand and gravel from all licenced and wayside sources have been maintained by the Owen Sound District Office of the Ontario Ministry of Natural Resources. The average annual production for licenced sources in the six-year period between 1977 and 1982 was 312,403 tons (283 412 tonnes). The annual produc-

tion for wayside pits averaged 24,210 tons (21 963 tonnes) for the same time period. Wayside pits are operated on demand under authority of a permit, for the purposes of local road construction projects.

One abandoned quarry has also been identified in the northwestern corner of the township near Alvanley. Extraction of bedrock has also occurred at several abandoned quarries located within the City of Owen Sound.

SELECTED SAND AND GRAVEL RESOURCE AREAS

Map 1 indicates the deposits which contain granular materials. These deposits occupy a total area of approximately 10,200 acres (4150 ha) and contain an original resource tonnage of 455 million tons (415 million tonnes). Many of these potential resource areas have limited value for reasons of deposit size, thickness, previous extraction or quality of the material. Consequently, only the most signifiant sources are suggested for protection at the primary level of significance.

The sand and gravel deposits selected for possible resource protection in Derby Township are shown on Map 2. Four ice-contact end moraine deposits along with an ice-contact delta, esker-delta, and two undifferentiated ice-contact deposits have been selected as Sand and Gravel Resource Areas of Primary Significance. These Primary Resource Areas have an estimated 2750 acres (1110 ha) currently available for extraction and contain granular resources of approximately 155 milllion tons (141 million tonnes). The parts of the selected areas which are available for extraction represent 27 percent of the total area occupied by sand and gravel deposits in the township and 34 percent of the original resource tonnage. The selected areas are readily accessible by road.

Several deposits have also been selected at the secondary level of significance. Although these deposits tend to be more limited in respect to the amount of available resources or the quality of the material than the resources selected at the primary level, they add significantly to the resource base of the township.

Several factors which limit the quality of the aggregate are a result of the variability of the sedimentation within the deposits selected for possible resource protection. Deike (1982) reports that the occurrence of soft, porous dolostone, minor chert and shale clasts in several pits restricts aggregate quality. Irregular amounts of fines related to clay-coated sand and gravel, silt and clay seams, and till pockets are also a significant quality constraint. There may also be zones of cemented aggregate and considerable quantities of oversize material in the aggregate deposits. Therefore, it is recommended that specific sites proposed for extraction should be thoroughly tested before development, especially if the aggregate is to be used for high-specification uses. Selective extraction and processing of the material may significantly improve aggregate quality.

SELECTED SAND AND GRAVEL RESOURCE AREA 1

Selected Sand and Gravel Resource Area 1 is made up of three deposits, labelled 1a, 1b and 1c, in the southeastern part of the township. Area 1a is a fan-shaped, ice-contact delta which has a generally uniform surface with the exception of the steep-sided slopes present along the edge of the deposit. Area 1b consists of morainic, ice-contact material and exhibits hummocky relief. The long sinuous ridge of Area 1c was deposited in eskerine and deltaic environments. Four licenced properties and four unlicenced sources have been developed in the Resource Area.

Pit no. 59 and the westernmost pit in licenced property no. 18 have been developed in Area 1a. Faces in pit no. 59 range from 10 to 20 feet (3 to 6 m) in height and expose variable material ranging from silty fine sand to coarse gravel. In places, the gravel is cemented and clay coated. Deike (1982) reports that the material in the pit is suitable for use as 16 mm Crushed B, granular base course and select subgrade material. Between 15 and 40 feet (5 and 12 m) of fine to coarse gravel with minor sand pockets was exposed in the western excavation of licenced property no. 18. Gradations performed on a sample taken of this material indicate a gravel content of 70 percent (Figure 2a). During field investigation cemented gravel layers, oversize clasts, shale clasts and reddish coloured fine coatings were observed in the pit which may restrict high- specification use of the aggregate. The oversize clasts, however, could be crushed in a primary crusher which would greatly improve aggregate quality (Deike 1982). A large proportion of Area 1a remains undeveloped and a considerable quantity of gravel may be available for extraction.

Three pits have been developed in Area 1b. Faces in the easternmost pit of licenced property no. 18 exposed up to 40 feet (12 m) of fine to coarse gravel. The gravel was frequently cemented and clay coated, and shale clasts were observed. Investigations performed by the Ontario Ministry of Transportation and Communications (M.T.C.) on the material in the pit and the surrounding area revealed variable quality, ranging from material suitable for Granular Base Course (G.B.C.) A and 16 mm Crushed B to material unsuitable for any use because of poor gravel quality and high fines content. Deike (1982) reports that the sandy aggregate exposed in pit nos. 60 and 61 is generally suitable for G.B.C. B and C and select subgrade material. Blending would be required to produce hot-laid asphaltic sand in pit no. 61. Varying quantities of oversize clasts were present in the pits.

Considerable extractive development has occurred in Area 1c. Up to 50 feet (15 m) of generally sandy fine gravel is exposed in pit no. 64. This material was sampled and found to contain 42 percent gravel, 56 percent sand and 2 percent fines (Figure 2a). Gradations performed on the sampled material indicate it may be suitable for use as G.B.C. B and C as well as some hot-laid asphaltic sand products. Selection and sand control would probably be required for G.B.C. A. Coarser gravel is exposed in licenced pits 19, 20 and 21. Deike (1982) reports that the material in these pits is generally suitable for 16 mm Crushed B, G.B.C. A, B and C, and select subgrade material. Irregular occurrences of dirty granular material necessitate selec-

tive extraction for crushing. Oversize clasts, also present in the pits, should be removed or crushed.

The M.T.C. has also tested the aggregate in five pits within Area 1 to determine petrographic number, resistance to abrasion, soundness and absorption (Deike 1982). Although the material is generally within specification limits for most aggregate products with respect to petrographic number and Los Angeles abrasion tests, consistently high values were obtained from Magnesium Sulphate soundness and absorption tests. The high values for these two tests restrict the use of the aggregate for high-specification products such as hot-laid asphaltic stone and concrete stone. The material in the pits in Area 1, however, is generally suitable for granular base course and select subgrade uses. Variable amounts of 16 mm Crushed A and B may also be available from Resource Area 1. With the exception of a few of the sources, the sand grades fine for use in hot-laid asphalt. Processing, such as crushing of oversize material and washing of the aggregate, could significantly improve aggregate quality in the Resource Area.

Resource Area 1 occupies 930 acres (375 ha), exclusive of licenced properties. Cultural setbacks and previous extraction reduce the area currently available to 740 acres (300 ha). Assuming an average deposit thickness of 30 feet (9 m), available resources are estimated to be 55 million tons (50 million tonnes).

SELECTED SAND AND GRAVEL RESOURCE AREA 2

Four deposits, designated 2a to 2d in the southwestern part of the township form Selected Sand and Gravel Resource Area 2. The east- west trending, often hummocky, ridges of ice-contact material associated with the Tara Moraines form Areas 2a, 2b and 2c. Area 2d is a north-south trending ridge consisting of ice-contact material deposited dominantly in an eskerine environment. Eight licenced properties and twelve unlicenced pits have been developed in Resource Area 2.

Of the six pits tested by the M.T.C. in Area 2a, three (pit nos. 9, 39 and 40) were capable of producing Hot-Laid (H.L.) No. 4 and 8 stone, 16 mm Crushed A and B and granular base course (Deike 1982). The aggregate in two of the sources (pit nos. 10 and 38) was determined to be suitable for use as G.B.C. B and C along with select subgrade uses. The sandy aggregate in pit no. 5 was acceptable for only select subgrade uses. This product variability reflects the variation of the quality of the aggregate in the pits. In some of the pits, notably pit nos. 5 and 13, till pockets and silt seams were abundant while in other sources good quality crushable gravel was present. Varying quantities of oversize clasts were also present in the Area's pits. Resources of quality crushable gravel may be available from the undeveloped parts of Area 2a, although detailed subsurface investigation would be required to delineate these resources.

Two licenced properties and three unlicenced pits have been opened in Area 2b. Although Area 2b has been classified as a sand source, the average gravel content in the Area's pits is marginal and resources consisting predominantly of gravel may be available in places from the deposit. Products such as hot-laid asphaltic stone, 16 mm Crushed B and granular base course have been produced from licenced pit no. 3. However, most of the quality gravel has been extracted from the pit and faces reveal up to 30 feet (9 m) of predominantly sand with occasional gravel pockets. The pit is no longer extensively used and most of the material processed by the permanent plant on the property is brought in from other pits in the area. Pit no. 32 contains similar material to that exposed in pit no. 3. Gravel is, however, relatively more abundant in pit nos. 4 and 35. In pit no. 4, 15 to 25 feet (5 to 8 m) of clean sandy gravel and gravelly sand is exposed, but a clay seam up to 4 feet (1.2 m) thick limits the quality of the aggregate available in the pit. Faces in pit no. 35 reveal 10 feet (3 m) of largely clean, sandy fine gravel which may be suitable for a number of aggregate uses. Area 2b is similar to Area 2a in that they are both moraine deposits. Consequently, similar quality variations and use capabilities are expected as those described for Area 2a.

Area 2c, a segment of the same moraine which forms Area 2b, has been classified separately from Area 2b on the basis of gravel content. One pit (pit no. 36) has been developed in this deposit with faces exposing between 10 and 20 feet (3 and 6 m) of fine to coarse gravel. The gravel is clean and lacks many of the quality limitations present in other pits in the township. The gravel content in the pit has been estimated to be 50 to 60 percent and the material may be suitable for a variety of aggregate products. Material of similar quality may be available from the undeveloped parts of Area 2c.

Three pits have been opened in Area 2d which is located in the southwestern corner of the township. Faces in pit nos. 2 and 26 reveal 15 to 20 feet (5 to 6 m) of variable material including till pockets, silty sand lenses and pockets of relatively clean sand and gravel. Because of the variability of the material, selective extraction of the cleaner material would probably be necessary to produce quality aggregate products. Finer material is exposed in pit no. 27 in the southern part of the deposit. In this pit, 5 to 15 feet (1.5 to 5 m) of clean gravelly sand is exposed which may be suitable for G.B.C. B and C, and select subgrade material.

Four pits in Area 2a and one in Area 2b have been tested by the M.T.C. to determine petrographic number, resistance to abrasion, soundness and absorption (Deike 1982). With the exception of one pit, the coarse aggregate from these sources fell within specification limits for these tests for most aggregate products including concrete stone and several hot-laid asphaltic stone products. Magnesium Sulphate soundness tests were also performed on the fine aggregate in three of the pits and yielded results within acceptable limits for hot-laid asphaltic and concrete sand, although blending would probably be required for these uses. A variety of aggregate products, ranging from hot-laid asphaltic stone to select subgrade uses, are capable of being produced from Resource Area 2. However, because of the variable nature of the aggregate, detailed testing of the material in the undeveloped parts of the Resource Area would be required to delineate areas containing significant quantities of quality aggregate.

Resource Area 2 occupies 2400 acres (970 ha), exclusive of licenced properties. Cultural constraints

and previous extraction reduce the area currently available to 1920 acres (780 ha). Assuming an average deposit thickness of 20 feet (6 m) for Areas 2a, 2b and 2c, and 15 feet (5 m) for Area 2d, available resources total 95 million tons (86 million tonnes).

SELECTED SAND AND GRAVEL RESOURCE AREA 3

Selected Sand and Gravel Resource Area 3 is an isolated ice- contact deposit located in the southwestern part of Derby Township. One pit (pit no. 30) has been developed in the deposit with faces exposing clean gravelly sand. The pit faces which range from 5 to 10 feet (1.5 to 3 m) are situated along a hillside exposing a total of about 25 feet (8 m) of material. Deike (1982) reports that the sand is of good quality and suitable for G.B.C. B and C, and select subgrade material. Sand control would be necessary to produce G.B.C. A and 16 mm Crushed B. Similar material may be present elsewhere in the deposit.

Resource Area 3 totals 110 acres (44 ha), of which 85 acres (34 ha) are currently available for extraction. Assuming an average deposit thickness of 25 feet (8 m), available resources are approximately 5 million tons (4 million tonnes).

SAND AND GRAVEL RESOURCE AREAS OF SECONDARY SIGNIFICANCE

The large morainic ice-contact deposit located south of the City of Owen Sound near Inglis Falls has been selected as a Sand and Gravel Resource Area of Secondary Significance. Five pits have been identified in this deposit and they expose generally sandy aggregate suitable for use as G.B.C. B and C, and select subgrade material. The presence of silt and clay seams, cemented gravel pockets and shale clasts in the pits restrict higher specification uses of the aggregate. A considerable proportion of the northeastern part of the deposit may be unavailable for extraction, however, as it lies within the policy areas of the Niagara Escarpment Commission.

Four other morainic ice-contact deposits have also been selected at the secondary level. Sandy gravel is exposed in pits within the deposit located near Squire. Deike (1982) reports that the material in pit no. 53 has been used for G.B.C. B and C, and select subgrade material. In the deposit located northwest of Resource Area 2a, one pit (pit no. 37) has been developed exposing largely clean medium sand. Possible uses of the aggregate in this pit include G.B.C. B and C and select subgrade material. Subsurface information is lacking for the two moraine deposits situated northwest of Resource Area 2b along the western boundary of the township. However, based on pit data from Area 2b, aggregate of varying quality may be available from these deposits.

An ice-contact delta and an esker deposit are located south of Resource Area 1c in the southeastern part of the township. One pit (pit no. 65) has been opened in the deltaic deposit and has faces exposing 30 to 40 feet (9 to 12 m) of predominantly gravelly sand suitable for use as G.B.C. B and C, and select subgrade material. The esker deposit, however, contains greater amounts of gravel and may be suitable for higher quality aggregate uses.

The remaining deposits selected at the secondary level of significance generally contain good quality resources but are restricted in respect to the amount of available resources. The esker-delta deposit in which licenced property 12 is located is one such deposit. The recently opened faces in pit no. 12 expose between 10 and 15 feet (3 and 5 m) of fine to coarse gravel with occasional sand lenses. This material was sampled and contained 73 percent gravel, 25 percent sand and 2 percent fines (Figure 2a). Pit no. 47, also located in the deposit, revealed sandy gravel suitable for use as 16 mm Crushed B, granular base course and select subgrade material.

The ice-contact deltaic deposit surrounding licenced property nos. 14 and 15 has also been selected. The deltaic material exposed in two pits within licenced property no. 14 and in pit nos. 48 and 49 consists of generally sandy aggregate suitable for use as G.B.C. B and C, and select subgrade material. A sample of this material from the westernmost excavation of pit no. 14 (sample 14b) contained 98 percent sand and 2 percent fines and gradations performed on this unprocessed aggregate indicate it may be suitable for some hot-laid asphaltic sand products (Figures 2a and 2b). In pit no. 48 higher concentrations of gravel were observed and the material may be suitable for a wider range of aggregate products.

Three pits have been developed in the ice-contact deposits located north of Resource Area 2a. Gravel of generally good quality is exposed in pit no. 45 while largely sandy aggregate is revealed in pit no. 6. Products available from these deposits include 16 mm Crushed A and B and granular base course (Deike 1982).

An esker deposit situated between Resource Areas 3 and 2d consists predominantly of fine to medium gravel with occasional sand pockets. Limited quantities of this material may be available for local use within the township.

The final area selected at the secondary level is an outwash deposit located near the western boundary of the township. Pit no. 25 exposes 20 feet (6 m) of generally good quality sandy gravel which may be suitable for a range of aggregate products. The boundary of this deposit has been based largely on topographic considerations and may require further testing to determine its true position.

BEDROCK GEOLOGY

Derby Township is underlain by shale of the Upper Ordovician Queenston Formation as well as by Lower to Middle Silurian strata of the Manitoulin, Cabot Head, Fossil Hill, Amabel and Guelph Formations. Drift overlying the bedrock is generally thinnest in the northern and eastern parts of the township with bedrock outcrops especially abundant near the Niagara Escarpment. This thinly drift-covered area has been referred to as the Bruce Peninsula physiographic region (Chapman and Putnam 1966). The Niagara Escarpment, a predominant bedrock feature in southern Ontario, attains heights up to 150 to 225 feet (46 to 69 m) above the Owen Sound re-entrant valley in the northeastern corner of the township. The escarpment near the City of Owen Sound consists of a prominent

bluff of Amabel dolostone and a secondary bench of Manitoulin dolostone.

The Queenston Formation, the oldest bedrock unit present in the township, underlies the Owen Sound valley and forms the base of the Niagara Escarpment. The formation consists of red shale with occasional beds of mottled green shale (Liberty and Bolton 1971). The Queenston shale, a resource of provincial significance for structural clay products, has not been selected for possible resource protection because of the thick drift cover.

The Queenston Formation is overlain by medium-bedded, fine-grained dolostone of the Manitoulin Formation. Goudge (1938) reports that in several now-abandoned quarries the cherty Manitoulin dolostone was extracted for use as crushed stone, rubble and foundation stone in the northeastern part of the City of Owen Sound. The formation in Derby Township, however, is of limited extent and generally covered by thick drift. Therefore, it has not been selected for possible resource protection.

The argillaceous and calcareous shale of the Cabot Head Formation overlies the Manitoulin dolostone and forms much of the face of the Niagara Escarpment (Liberty and Bolton 1971). The shale is too soft for the production of load-bearing aggregate and has been mapped together with the Manitoulin dolostone on Map 3 as both formations are restricted in extent.

The Fossil Hill Formation can be observed overlying the Cabot Head shale along the face of the escarpment. Near Inglis Falls, approximately 8 feet (2 m) of the medium-grained, fossiliferous dolostone of this formation is exposed (Bolton 1957; Telford 1978). The formation is often cherty and irregularly bedded. Since exposures of the Fossil Hill dolostone are extremely limited along the face of the escarpment, the formation has been grouped together with the overlying Amabel Formation on Map 3.

The Fossil Hill Formation is overlain by the erosion-resistant dolostone of the Amabel Formation which forms the caprock of the Niagara Escarpment and underlies a considerable proportion of the township south and west of the escarpment. The formation consists of fine-grained dolostone, although, minor amounts of porous medium- to coarse-grained dolstone and patchy occurrences of thin-bedded, dark brown, bituminous dolostone occur (Bolton 1957; Liberty and Bolton 1971). The porous, coarser-grained dolostone is often associated with fossil reef structures which form topographic highs; dark brown, bituminous dolostone occurs locally between the reef structures. Minor amounts of chert may also occur in the dolostone, especially near the base of the formation.

The Amabel Formation is an important aggregate source in southern Ontario and is suitable for the production of a wide variety of industrial mineral uses including crushed stone, concrete aggregate, building stone and lime. Although the dolostone is generally of high quality and has been selected for possible resource protection, reef structures where present in the formation may restrict the quality of the bedrock. The massive beds and irregular surfaces of the reefs may influence the workability of the rock (Hewitt 1960) and the porous nature of the reefal dolostone would be expected to increase absorptive characteristics of the aggregate. Aggregate having absorptive values greater than the M.T.C. specification limits is generally satisfactory for structural concrete applications, but usually has a low resistance to abrasion and should not be used in asphalt surface course construction (Deike 1982). In addition, chert may restrict high-specification uses of the dolostone, where it is abundant in the formation.

The youngest bedrock unit in the report area, the Guelph Formation, underlies a large area in the southern and western parts of the township. The formation is typically a buff and brown, fine-to medium-grained dolostone and both reefal and inter-reefal varieties occur (Liberty and Bolton 1971). The massive, porous, softer, coarser-grained reefal strata are not as well suited for aggregate use as the evenly-bedded inter-reefal dolostone (B.H. Feenstra, Mineral Resources Geologist, Ontario Ministry of Natural Resources, London, personal communicaton, 1982). In addition, the Guelph dolostone is a valuable raw material for a variety of metallurgical products as it usually has a high chemical purity and it is quarried for the production of dolomitic lime near Guelph and Hamilton. The formation has not been selected for possible resource protection as large resources of generally more durable Amabel dolostone are available in the township and immediate local markets for metallurgical products are lacking. One presently abandoned quarry has been developed in Guelph dolostone in the northwestern corner of the township near Alvanley.

SELECTED BEDROCK RESOURCE AREA 1

Selected Bedrock Resource Area 1 consists of Amabel dolostone overlain by less than 25 feet (8 m) of overburden. The Fossil Hill Formation has been mapped together with the Amabel Formation, but exposures occur only along the face of the Niagara Escarpment and the formation is limited in thickness. Consequently, the Amabel Formation is the most important bedrock unit in the Resource Area. The generally high-quality Amabel dolostone is a valuable industrial mineral resource in southern Ontario. Several quarries have been developed in Amabel dolostone along the escarpment within the City of Owen Sound and between Springmount and the city's western boundary (Goudge 1938). These quarries, operated at the turn of the century, are presently abandoned and have not been shown on Map 3. Goudge (1938) reports that the dolostone extracted in these quarries was used largely for the manufacture of lime as well as for building and crushed stone. More recently, a quarry was developed in Amabel dolostone east of the City of Owen Sound in Sydenham Township. A wide variety of products are produced in this quarry.

Although the Amabel dolostone is usually of high quality, porous reefal structures and chert (where abundant) may restrict some high- specification uses of the aggregate. For these reasons, the quality of the bedrock should be investigated at specific sites proposed for possible quarry development before extraction. A significant thickness of Amabel dolostone may be available for extraction as exposures up to 40 feet (12 m) high were observed along the brow of the escarpment and the formation thickens in an apparent

southwesterly direction away from the escarpment (Vos 1969).

Resource Area 1 occupies a total of 9600 acres (3900 ha), of which 8200 acres (3300 ha) are currently available for extraction. Assuming a workable thickness of 60 feet (18 m), available bedrock resources are approximately 1770 million tons (1610 million tonnes). A significant proportion of the land along the escarpment near Springmount and Inglis Falls lies within policy areas of the Niagara Escarpment Commission. Area 1 is readily accessible by road and a rail line traverses the western part of Sydenham Township, near the eastern boundary of the Area.

SUMMARY

The sand and gravel deposits of Derby Township are the product of glacial activity which occurred during the Late Wisconsinan. Eight of these deposits containing significant amounts of sand and gravel have been selected at the primary level of signficance. The deposits have been grouped into three Primary Resource Areas and consist of aggregate of varying quality, suitable for a range of aggregate uses. Several deposits of secondary significance have also been selected and these deposits considerably add to the township's resource base. Care should be taken to ensure the continued availability of as much of the resource areas as possible.

Bedrock of Upper Ordovician to Middle Silurian age underlies the township. The Amabel Formation is considered the best suited for possible extractive development. One area consisting of this formation has been selected for possible resource protection. The generally high-quality Amabel dolostone is suitable for the production of a wide range of industrial mineral products.

Enquiries regarding the Aggregate Resources Inventory of Derby Township should be directed to the Ontario Ministry of Natural Resources either at the Owen Sound District Office, 611-9th Avenue East, Owen Sound, Ontario, N4K 3E4 (Tel. (519) 376-3860) or at the Southwestern Region Geological Office, 458 Central Avenue, London, Ontario, N6B 2E5 (Tel. (519) 433-8431).

TABLE 1. TOTAL SAND AND GRAVEL RESOURCES, DERBY TOWNSHIP*.

1 Class No.	2 Deposit Type (see Appendix C)	3 Areal Extent Acres (Hectares)	4 Original Tonnage Millions of Tons (Tonnes)
1	G-E-LD	260 (105)	20 (18)
	G-IC	40 (16)	2 (2)
	S-IC	132 (53)	8 (7)
	G-IC-EM	1830 (740)	102 (92)
	S-IC-EM	2070 (840)	106 (96)
	G-IC-LD	495 (200)	37 (34)
	S-IC-LD	445 (180)	26 (24)
	G-K	78 (32)	5 (4)
2	G-E	91 (37)	3 (3)
	G-E-LD	83 (34)	3 (3)
	G-IC	31 (13)	1 (1)
	S-IC	180 (73)	7 (6)
	G-IC-E	150 (61)	6 (5)
	G-IC-EM	237 (96)	9 (8)
	S-IC-EM	670 (270)	25 (23)
	S-IC-LD	310 (125)	13 (12)
	G-K	46 (19)	2 (2)
	S-LP	910 (370)	34 (31)
	G-OW	22 (9)	1 (1)
	S-OW	20 (8)	1 (1)
3	G-E	38 (15)	1 (1)
	S-E	12 (5)	<1 (<1)
	G-IC	14 (6)	<1 (<1)
	S-IC	134 (54)	3 (3)
	S-LP	1880 (760)	38 (34)
		10,200 (4150)	455 (415)

N.B. Minor variations in all tables are caused by rounding of data.
*Identified deposits within the City of Owen Sound have been omitted on all tables.

TABLE 2. SAND AND GRAVEL PITS, DERBY TOWNSHIP.

1 No.	2 MTC No.	3 Owner/ Operator	4 Lot	5 Con.	6 Licenced Areas Acres (Hectares)	7 Face Height Feet Metres	8 % Gravel
LICENCED PITS							
1	-	M. McKnight	13	12	12.8 (5.2)	10 (3)	variable
2	-	A. Skaisgirsky	S1/2 5	12	48.6 (19.7)	15-20 (5-6)	30-50 variable
3	C21-003	E.C. King Contracting Ltd	5,6	11	71.5 (28.9)	30 (9)	10-30
4	-	E.C. King Contracting Ltd	3	9	32.5 (13.2)	15-25 (5-8)	20-40
5	W06-106	L. Barfoot	9	9	102.0 (41.3)	10-15 (3-5)	5-20
6	W06-014	M. Cook	10	8	33.8 (13.7)	25 (8)	10
7	-	R. Legge	Pt.14, 15	8	13.5 (5.5)	20 (6)	<5
8	W06-110	J.A. Davidson	8	8	45.5 (18.4)		unopened
9	W06-100	M. Mundle	8	8	36.5 (14.8)	20 (6)	25-35
10	W06-107	K. Barfoot	N1/2 7	8	20.0 (8.1)	20 (6)	25
11	W06-114	K. Barfoot	8	7	27.0 (10.9)		unopened
12	-	K. Peer Ltd.	Pt.7	6	30.1 (12.2)	10-15 (3-5)	25-75
13	C21-074	C. Kramer Construction Ltd.	N1/2 5	6	81.0 (32.8)	20 (6)	20-50 variable
14	M04-104 M04-012	N. Downs	2,3	6	324.0 (131.1)	20-30 (6-9)	0-80
15	M04-104	N. Downs	3	6	50.0 (20.2)	15-30 (5-9)	35
16	O06-065	D. Curry	E1/2 9	5	10.2 (4.1)	5 (1.5)	variable
17	O06-029	F. Coulter	Pt.10	2	9.0 (3.6)	10-30 (3-9)	20-25
18	O06-044	R. Lunau	8	3	97.6 (39.5)	15-40 (5-12)	35-70
19	M04-080	E.C. King Contracting Ltd.	5	3	55.3 (22.4)	20-50 (6-15)	40-60
20	M04-001 M04-139	B. Mervyn Construction Ltd	4	3	89.8 (36.3)	5-35 (1.5-11	35-60
21	M04-002	A. Albright	Pt.3,4	3	71.1 (28.8)	10 (3)	5-50
					1261.8 (510.6)		

N.B. Minor variations in all tables are caused by rounding of data.

TABLE 2. SAND AND GRAVEL PITS, DERBY TOWNSHIP.

1 No.	2 MTC No.	3 Owner/ Operator	4 Lot	5 Con.	6 Licenced Areas Acres (Hectares)	7 Face Height Feet Metres	8 % Gravel
UNLICENCED PITS*							
22	-	unknown	15	11		8 (2)	40 variable
23	-	unknown	9	12		8 (2)	overgrown
24	-	unknown	9	11		5 (1.5)	overgrown
25	-	unknown	9	12		20 (6)	30-50
26	-	unknown	5	12		15-20 (5-6)	variable, partially overgrown
27	-	unknown	3	12		5-15 (1.5-5)	10-25
28	-	unknown	3	11		5-10 (1.5-3)	overgrown
29	-	unknown	3	11		10-20 (3-6)	20-50
30	C21-061	F. Heathers	2	9		5-10 (1.5-3)	10-30
31	-	unknown	2	9		10 (3)	50 over till
32	-	unknown	5,6	10		10-40 (3-12)	variable, partially overgrown
33	-	unknown	7	10		5-8 (1.5-2)	sand with gravel pockets, partially overgrown
34	-	unknown	4	9		15 (5)	overgrown
35	-	unknown	5	9		10 (3)	30-45
36	-	unknown	2	8		10-20 (3-6)	50-60
37	-	unknown	11	10		10 (3)	5
38	C21-062	Brown	8	9		5-10 (1.5-3)	35 variable
39	C21-066	J. Cook	7	8		5-8 (1.5-2)	variable
40	C21-007	H. Cook	6	8		5-20 (1.5-6)	40-60
41	-	unknown	8	9		5-10 (1.5-3)	overgrown

N.B. Minor variations in all tables are caused by rounding of data.

*Abandoned pits or wayside pits operating on demand under authority of a permit.

TABLE 2. SAND AND GRAVEL PITS, DERBY TOWNSHIP.

1 No.	2 MTC No.	3 Owner/ Operator	4 Lot	5 Con.	6 Licenced Areas Acres (Hectares)	7 Face Height Feet Metres	8 % Gravel
42	-	unknown	9	8		5-10 (1.5-3)	50-60
43	-	unknown	9	8		5-10 (1.5-3)	overgrown
44	-	unknown	9	8		12 (4)	overgrown
45	-	M. Cook	9	8		20 (6)	30-50
46	W06-046	H. Hall	10	Indian Strip		5-20 (1.5-6)	35 variable
47	M04-072	E. Vokes	6	6		10 (3)	35-40
48	-	unknown	1	6		20 (6)	25-40
49	M04-109	A. Kuhl	1	6		10-20 (3-6)	mainly sandy, some gravel
50	-	unknown	16	4		10 (3)	overgrown
51	-	unknown	10,11	5		5-12 (1.5-4)	20-40
52	-	unknown	10	5		5-13 (1.5-4)	30-35
53	O06-055	D. Warner	10	4			rehabilitated
54	-	unknown	12	2		5-15 (1.5-5)	sand, partially overgrown
55	O06-028	Whitney	10	2		25-35 (8-11)	sand
56	-	unknown	10	2		10-20 (3-6)	10 variable
57	O06-045	unknown	10	3		10 (3)	mainly sand, overgrown
58	O06-002	Byers	9	2		5-8 (1.5-2)	sand over cemented gravel
59	O06-046	J. Smith	9	3		10-20 (3-6)	10-50
60	O06-048	Barber	8	3			rehabilitated
61	O06-053	Cameron	8	2		5-10 (1.5-3)	mainly sand, variable
62	-	unknown	6	2		5-15 (1.5-5)	overgrown
63	-	unknown	6	1		2-5 (0.6-1.5)	20 over bedrock

N.B. Minor variations in all tables are caused by rounding of data.

TABLE 2. SAND AND GRAVEL PITS, DERBY TOWNSHIP.

1 No.	2 MTC No.	3 Owner / Operator	4 Lot	5 Con.	6 Licenced Areas Acres (Hectares)	7 Face Height Feet Metres	8 % Gravel
64	-	unknown	6	3		40-50 (12-15)	40-50
65	M04-004	D. Wilson	2	3		30-40 (9-12)	25-30

N.B. Minor variations in all tables are caused by rounding of data.

TABLE 3. SELECTED SAND AND GRAVEL RESOURCE AREAS, DERBY TOWNSHIP.

1 Deposit No.	2 Unlicenced Area Acres (Hectares)	3 Cultural Setbacks Acres (Hectares)	4 Extracted Area Acres (Hectares)	5 Available Area Acres (Hectares)	6 Estimated Deposit Thickness Feet (Metres)	7 Available Aggregate Millions of Tons (Tonnes)
1a	450	70	10	370	30	28
	(182)	(28)	(4)	(150)	(9)	(25)
1b	355	40	60	255	30	19
	(144)	(16)	(24)	(103)	(9)	(17)
1c	125	10	5	110	30	8
	(51)	(4)	(2)	(44)	(9)	(7)
	930	120	75	740		55
	(375)	(49)	(30)	(300)		(50)
2a	1170	170	100	900	20	45
	(475)	(69)	(40)	(365)	(6)	(41)
2b	1010	140	40	830	20	42
	(410)	(57)	(16)	(335)	(6)	(38)
2c	90	0	5	85	20	4
	(36)	(0)	(2)	(34)	(6)	(4)
2d	130	20	5	105	15	4
	(53)	(8)	(2)	(42)	(5)	(4)
	2400	330	150	1920		95
	(970)	(134)	(61)	(780)		(86)
3	110	0	25	85	25	5
	(44)	(0)	(10)	(34)	(8)	(4)
	3450	450	250	2750		155
	(1400)	(182)	(101)	(1110)		(141)

N.B. Minor variations in all tables are caused by rounding of data.

TABLE 4. TOTAL IDENTIFIED BEDROCK RESOURCES, DERBY TOWNSHIP

1 **DRIFT THICKNESS** Feet (Metres)	2 **FORMATION**	3 **ESTIMATED DEPOSIT THICKNESS** Feet (Metres)	4 **AREAL EXTENT** Acres (Hectares)	5 **ORIGINAL TONNAGE** Millions of Tons (Tonnes)
0-3	Guelph	60	390	84
(0-1)		(18)	(158)	(76)
3-25	Guelph	60	10,500	2270
(1-8)		(18)	(4250)	(2060)
25-50	Guelph	60	12,600	2700
(8-15)		(18)	(5100)	(2450)
			23,500	5000
			(9500)	(4550)
0-3	Amabel &	60	3500	760
(0-1)	Fossil Hill	(18)	(1420)	(690)
3-25	Amabel &	60	6100	1320
(1-8)	Fossil Hill	(18)	(2470)	(1200)
25-50	Amabel &	60	930	201
(8-15)	Fossil Hill	(18)	(375)	(182)
			10,500	2280
			(4250)	(2070)
0-3	Cabot Head &	60	75	15
(0-1)	Manitoulin	(18)	(30)	(14)
3-25	Cabot Head &	60	170	35
(1-8)	Manitoulin	(18)	(69)	(32)
25-50	Cabot Head &	60	465	95
(8-15)	Manitoulin	(18)	(188)	(86)
			710	145
			(285)	(132)
25-50	Queenston	60	80	15
(8-15)		(18)	(32)	(14)
			35,000	7400
			(14 200)	(6700)

N.B. Minor variations in all tables are caused by rounding of data.

TABLE 5. QUARRIES, DERBY TOWNSHIP.

1 NO.	2 MTC NO.	3 OWNER/ OPERATOR	4 LOT	5 CON.	6 LICENCED AREA Acres (Hectares)	7 FACE HEIGHT Feet (Metres)
UNLICENCED QUARRIES*						
1	-	unknown	20	Indian Strip	-	15 (5)

N.B. Minor variations in all tables are caused by rounding of data.

*Abandoned quarries or wayside quarries operating on demand under authority of a permit.

TABLE 6. SELECTED BEDROCK RESOURCE AREAS, DERBY TOWNSHIP.

1 DEPOSIT NO.	2 DEPTH OF OVERBURDEN Feet (Metres)	3 UNLICENCED AREA Acres (Hectares)	4 CULTURAL SETBACKS Acres (Hectares)	5 EXTRACTED AREA Acres (Hectares)	6 AVAILABLE AREA Acres (Hectares)	7 ESTIMATED WORKABLE THICKNESS Feet (Metres)	8 AVAILABLE RESOURCES Millions of Tons (Tonnes)
1	0-25 (0-8)	9600 (3900)	1400 (570)	0 (0)	8200 (3300)	60 (18)	1770 (1610)

N.B. Minor variations in all tables are caused by rounding of data.

TABLE 7. SUMMARY OF TEST HOLE DATA, DERBY TOWNSHIP.

-NONE-

N.B. Minor variations in all tables are caused by rounding of data.

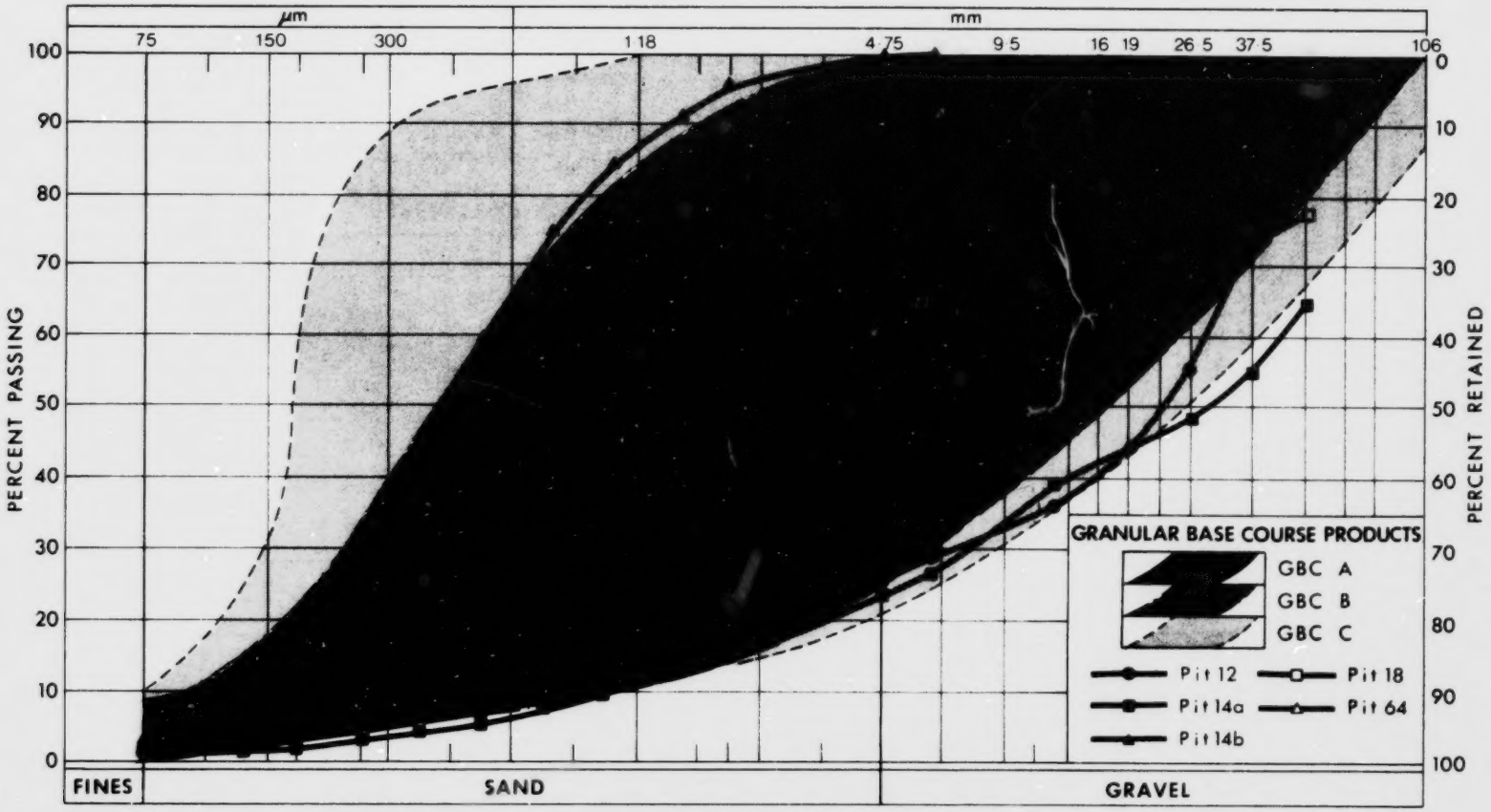


FIGURE 2a: AGGREGATE GRADING CURVES, DERBY TOWNSHIP;

Based on analysis of the total aggregate contained in unprocessed samples (gradation envelopes adapted from M.T.C. Form 1010, 1980).

NOTE. Information portrayed by grading curves refers strictly to a specific sample taken at the time of field investigation. Due to the inherent variability of sand and gravel deposits care should be exercised in extrapolating such information to the rest of the deposit.

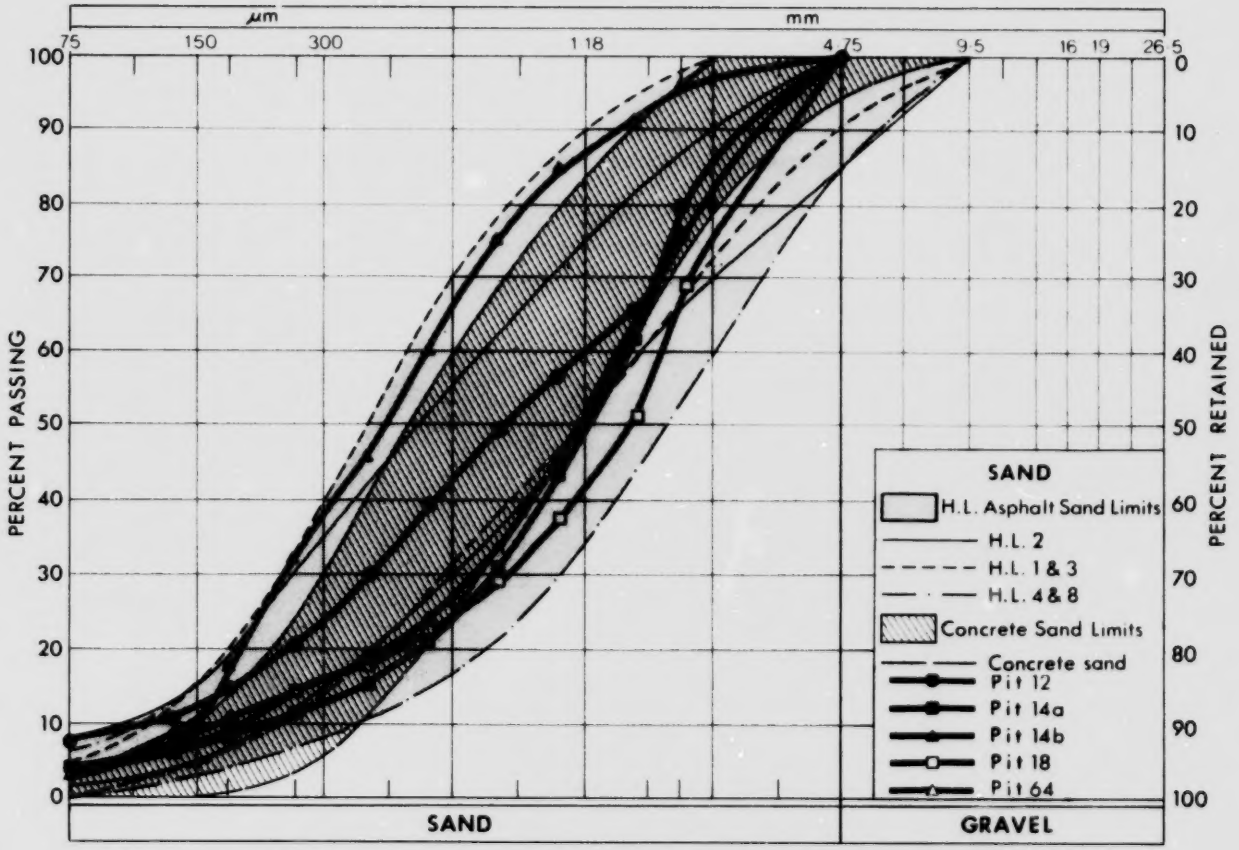


FIGURE 2b: AGGREGATE GRADING CURVES, DERBY TOWNSHIP;

Based on analysis of the sand fraction of the aggregate contained in unprocessed samples (gradation envelopes adapted from M.T.C. Forms 1002, 1979 and 1003, 1981).

NOTE:

Information portrayed by grading curves refers strictly to a specific sample taken at the time of field investigation. Due to the inherent variability of sand and gravel deposits care should be exercised in extrapolating such information to the rest of the deposit.

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Appendix A — Suggested Additional Reading

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Appendix B — Glossary

Abrasion resistance: Tests such as the Los Angeles abrasion test are used to measure the ability of aggregate to resist crushing and pulverizing under conditions similar to those encountered in processing and use. Measuring resistance is an important component in the evaluation of the quality and prospective uses of aggregate. Hard, durable material is preferred for road building.

Absorption capacity: Related to the porosity of the rock types of which an aggregate is composed. Porous rocks are subject to disintegration when absorbed liquids freeze and thaw, thus decreasing the strength of the aggregate.

Aggregate: Any hard, inert, construction material (sand, gravel, shells, slag, crushed stone or other mineral material) used for mixing in various-sized fragments with a cement or bituminous material to form concrete, mortar, etc., or used alone for road building or other construction. Synonyms include mineral aggregate and granular material.

Alkali-aggregate reaction: A chemical reaction between the alkalis of portland cement and certain minerals found in rocks used for aggregate. Alkali-aggregate reactions are undesirable because they can cause expansion and cracking of concrete. Although perfectly suitable for building stone and asphalt applications, alkali-reactive aggregates should be avoided for structural concrete uses.

Blending: Required in cases of extreme coarseness, fineness, or other irregularities in the gradation of unprocessed aggregate. Blending is done with approved sand-sized aggregate in order to satisfy the gradation requirements of the material.

Cambrian: The first period of the Palezoic Era, thought to have covered the time between 570 and 500 million years ago. The Cambrian precedes the Ordovician Period.

Clast: An individual constituent, grain or fragment of a sediment or rock, produced by the mechanical weathering of larger rock mass. Synonyms include particle and fragment.

Crushable aggregate: Unprocessed gravel containing a minimum of 35 percent coarse aggregate larger than the No. 4 sieve (4.75 mm) as well as a minimum of 20 percent greater than the 26.5 mm sieve.

Deleterious lithology: A general term used to designate those rock types which are chemically or physically unsuited for use as construction or road-building aggregates. Such lithologies as chert, shale, siltstone and sandstone may deteriorate rapidly when exposed to traffic and other environmental conditions.

Devonian: A period of the Paleozoic Era thought to have covered the span of time between 395 and 345 million years ago, following the Silurian Period. Rocks formed in the Devonian Period are among the youngest found in Ontario.

Dolostone: A carbonate sedimentary rock consisting chiefly of the mineral dolomite and containing relatively little calcite (dolostone is also known as dolomite).

Drift: A general term for all unconsolidated rock debris transported from one place and deposited in another, distinguished from underlying bedrock. In North America, glacial activity has been the dominant mode of transport and deposition of drift. Synonyms include overburden and surficial deposit.

Drumlin: A low, smoothly rounded, elongated hill, mound, or ridge composed of glacial materials. These landforms were formed beneath an advancing ice sheet, and were shaped by its flow.

Eolian: Pertaining to the wind, especially with respect to landforms whose constituents were transported and deposited by wind activity. Sand dunes are an example of an eolian landform.

Fines: A general term used to describe the size fraction of an aggregate which passes (is finer than) the No. 200 mesh screen (0.075 mm). Also described informally as "dirt", these particles are in the silt and clay size range.

Glacial lobe: A tongue-like projection from the margin of the main mass of an ice cap or ice sheet. During the Pleistocene Epoch several lobes of the Laurentide continental ice sheet occupied the Great Lakes basins. These lobes advanced then melted back numerous times during the Pleistocene, producing the complex arrangement of glacial material and landforms found in southern Ontario.

Gradation: The proportion of material of each particle size, or the frequency distribution of the various sizes which constitute a sediment. The strength, durability, permeability and stability of an aggregate depend to a great extent on its gradation. The size limits for different particles are as follows:

Boulder	more than 200 mm
Cobbles	75-200 mm
Coarse Gravel	26.5-75 mm
Fine Gravel	4.75-26.5 mm
Coarse Sand	2-4.75 mm
Medium Sand	0.425-2 mm
Fine Sand	0.075-0.425 mm
Silt, Clay	less than 0.075 mm

Granular base course: Components of the pavement structure of a road, which are placed on the subgrade and are designed to provide strength, stability and drainage, as well as support for surfacing materials. Several types have been defined: Granular Base Course A consists of crushed and processed aggregate and has relatively stringent quality standards in comparison to Granular Base Course B and C which are usually pit-run or other unprocessed aggregate.

Hot-laid (or asphaltic) aggregate: Bituminous, cemented aggregates used in the construction of pavements either as surface or bearing course (H.L. 1, 3 and 4), or as binder course (H.L. 2 and 8) used to bind the surface course to the underlying granular base course.

Lithology: The description of rocks on the basis of such characteristics as color, structure, mineralogic composition and grain size. Generally, the description of the physical character of a rock.

Magnesium sulphate soundness test: This test is designed to simulate the action of freezing and thawing on aggregates. Those aggregates which are susceptible will usually break down and give high losses in this test.

Meltwater channel: A drainage way, often terraced, produced by water flowing away from a melting glacier margin.

Ordovician: an early period of the Paleozoic Era thought to have covered the span of time between 500 and 435 million years ago.

Paleozoic Era: One of the major divisions of the geologic time scale thought to have covered the time between 570 and 230 million years ago, the Paleozoic Era (or Ancient Life Era) is subdivided into six geologic periods, of which only four (Cambrian, Ordovician, Silurian and Devonian) can be recognized in southern Ontario.

Petrographic examination: An aggregate quality test based on known field performance of various rock types. The test result is a Petrographic Number (P.N.). The higher the P.N. the lower the quality of the aggregate.

Pleistocene: An epoch of the recent geological past including the time from approximately 2 million years ago to 7000 years ago. Much of the Pleistocene was characterized by extensive glacial activity and is popularly referred to as the "Great Ice Age".

Possible resource: Reserve estimates based largely on broad knowledge of the geological character of the deposit and for which there are few, if any, samples or measurements. The estimates are based on assumed continuity or repetition for which there are reasonable geological indications.

Shale: A fine-grained, sedimentary rock formed by the consolidation of clay, silt or mud and characterized by well developed bedding planes, along which the rock breaks readily into thin layers. The term shale is also commonly used for fissile claystone, siltstone and mudstone.

Silurian: An early period of the Palezoic Era thought to have covered the time between 435 and 395 million years ago. The Silurian follows the Ordovician Period and precedes the Devonian Period.

Soundness: The ability of the components of an aggregate to withstand the effects of various weathering processes and agents. Unsound lithologies are subject to disintegration caused by the expansion of absorbed solutions. This may seriously impair the performance of road-building and construction aggregates.

Till: Unsorted and unstratified rock debris, deposited directly by glaciers, and ranging in size from clay to large boulders.

Wisconsinan: Pertaining to the last glacial period of the Pleistocene Epoch in North America. The Wisconsinan began approximately 100 000 years ago and ended approximately 7000 years ago. The glacial deposits and landforms of southern Ontario are predominantly the result of glacial activity during the Wisconsinan Stage.

Appendix C — Geology of Sand and Gravel Deposits

The type, distribution, and extent of sand and gravel deposits in southern Ontario are the result of extensive glacial and glacially influenced activity in Wisconsinan time during the Pleistocene Epoch, approximately 100 000 to 7000 years ago. The deposit types reflect the different depositional environments that existed during the melting and retreat of the continental ice masses, and can readily be differentiated on the basis of their morphology, structure, and texture. The deposit types are described below.

GLACIOFLUVIAL DEPOSITS

These deposits can be divided into two broad categories: those that were formed in contact with (or in close proximity to) glacial ice, and those that were deposited by meltwaters carrying materials beyond the ice margin.

Ice-Contact Terraces (ICT): These are glaciofluvial features deposited between the glacial margin and a confining topographic high, such as the side of a valley. The structure of the deposits may be similar to that of outwash deposits, but in most cases the sorting and grading of the material is more variable and the bedding is discontinuous because of extensive slumping. The probability of locating large amounts of crushable aggregate is moderate, and extraction may be expensive because of the variability of the deposits both in terms of quality and grain size distribution.

Kames (K): Kames are defined as mounds of poorly sorted sand and gravel deposited by meltwater in depressions or fissures on the ice surface or at its margin. During glacial retreat, the melting of supporting ice causes collapse of the deposits, producing internal structures characterized by bedding discontinuties. The deposits consist mainly of irregularly bedded and crossbedded, poorly sorted sand and gravel. The present forms of the deposits include single mounds, linear ridges (crevasse fillings) or complex groups of landforms. The latter are occasionally described as "undifferentiated ice-contact stratified drift" (IC) when detailed subsurface information is unavailable. Since kames commonly contain large amounts of fine-grained material and are characterized by considerable variability, there is generally a low to moderate probability of discovering large amounts of good quality, crushable aggregate. Extractive problems encountered in these deposits are mainly the excessive variability of the aggregate and the rare presence of excess fines (silt- and clay-sized particles).

Eskers (E): Eskers are narrow, sinuous ridges of sand and gravel deposited by meltwaters flowing in tunnels within or at the base of glaciers, or in channels on the ice surface. Eskers vary greatly in size. Many, though not all eskers consist of a central core of poorly sorted and stratified gravel characterized by a wide range in grain size. The core material is often draped on its flanks by better sorted and stratified gravel characterized by a wide range in grain size. The core material is often draped on its flanks by better sorted and stratified sand and gravel. The deposits have a high probability of containing a large proportion of crushable aggregate, and since they are generally built above the surrounding ground surface, are convenient extraction sites. For these reasons esker deposits have been traditional aggregate sources throughout Ontario, and are significant components of the total resources of many areas.

Some planning constraints and opportunities are inherent in the nature of the deposits. Because of their linear nature, the deposits commonly extend across several property boundaries leading to unorganized extractive development at numerous small pits. On the other hand, because of their form, eskers can be easily and inexpensively extracted and are amenable to rehabilitation and sequential land use.

Undifferentiated Ice-Contact Stratified Drift (IC): This designation may include deposits from several ice-contact, depositional environments which usually form extensive, complex landforms. It is not feasible to identify individual areas of coarse-grained material within such deposits because of their lack of continuity and grain size variability. They are given a qualitative rating based on existing pit and other subsurface data.

Outwash (OW): Outwash deposits consist of sand and gravel laid down by meltwaters beyond the margin of the ice lobes. The deposits occur as sheets or as terraced valley fills (valley trains) and may be very large in extent and thickness. Well developed outwash deposits have good horizontal bedding and are uniform in grain size distribution. Outwash deposited near the glacier's margin is much more variable in texture and structure. The probability of locating useful crushable aggregates in outwash deposits is moderate to high depending on how much information on size, distribution and thickness is available.

Alluvium (AL): Alluvium is a general term for clay, silt, sand, gravel, or similar unconsolidated material deposited during postglacial time by a stream as sorted or semi-sorted sediment, on its bed or on its floodplain. The probability of locating large amounts of crushable aggregate in alluvial deposits is low, and they have generally low value because of the presence of excess silt- and clay-sized material. There are few large postglacial alluvium deposits in Ontario.

GLACIOLACUSTRINE DEPOSITS

Glaciolacustrine Beach Deposits (LB): These are relatively narrow, linear features formed by wave action at the shores of glacial lakes that existed at various times during the deglaciation of southern Ontario. Well developed lacustrine beaches are usually less than 20 feet (6 m) thick. The aggregate is well sorted and stratified and sand-sized material commonly predominates. The composition and size distribution of the deposit depends on the nature of the source material. The probability of obtaining crushable aggregate is high when the material is developed from coarse-grained materials such as a stony till, and low when developed from fine-grained materials. Beaches are relatively narrow, linear deposits, so that extractive operations are often numerous and extensive.

Glaciolacustrine Deltas (LD): These features were formed where streams or rivers of glacial meltwater flowed into lakes and deposited their suspended sediment. In southern Ontario such deposits tend to consist mainly of sand and abundant silt. However, in near- ice and ice-contact positions, coarse material may be present. Although deltaic deposits may be large, the probability of obtaining coarse material is generally low.

Glaciolacustrine Plains (LP): The nearly level surface marking the floor of an extinct glacial lake. The sediments which form the plain are predominantly fine to medium sand, silt, and clay, and were deposited in relatively deep water. Lacustrine deposits are generally of low value as aggregate sources because of their fine grain size and lack of crushable material. In some aggregate-poor areas, lacustrine deposits may constitute valuable sources of fill and some granular base course aggregate.

GLACIAL DEPOSITS

End Moraines (EM): These are belts of glacial drift deposited at, and parallel to, glacier margins. End moraines commonly consist of ice-contact stratified drift and in such instances are usually called kame moraines. Kame moraines commonly result from deposition between two glacial lobes (interlobate moraines). The probability of locating aggregates within such features is moderate to low. Exploration and development costs are high. Moraines may be very large and contain vast aggregate resources, but the location of the best areas within the moraine is usually poorly defined.

EOLIAN DEPOSITS

Windblown Deposits (WD): Windblown deposits are those formed by the transport and deposition of sand by winds. The form of the deposits ranges from extensive, thin layers to well developed linear and crescentic ridges known as dunes. Most windblown deposits in southern Ontario are derived from, and deposited on, pre-existing lacustrine sand plain deposits. Windblown sediments almost always consists of fine to coarse sand and are usually well sorted. The probabilitiy of locating crushable aggregate in windblown deposits is very low.

Appendix D — Geology of Bedrock Deposits

BEDROCK SUITABLE FOR CRUSHED STONE PRODUCTS

Bass Islands Formation (Upper Silurian)

(Includes the Bertie Formation of the Niagara Peninsula) Composition: Medium- to massive-bedded, aphanitic, brown dolostone with shaly partings. Thickness: 35 to 60 feet (11 to 18 m) near Hagersville. Uses: Quarried for crushed stone on the Niagara Peninsula at Fort Erie, Cayuga, Hagersville, and Dunnville. Los Angeles Abrasion Test: 17-35% loss; Absorption: 1.4%. Shaly parts are unsuitable for aggregate because of high soundness losses.

Bobcaygeon Formation (Middle Ordovician)

Composition: Compact, homogeneous, medium- to thin-bedded, fine- grained limestone with some argillaceous and shaly partings. Thickness: The lower unit is 40 to 72 feet (12 to 22 m) thick in the east and the remainder of the formation is 40 feet (12 m). Uses: Quarried at Kirkfield and Marysville for crushed stone. The Bobcaygeon Formation has consistently acceptable quality for granular base course materials and concrete.

Bois Blanc Formation (Lower-Middle Devonian)

Composition: Brownish grey, medium-crystalline, medium- to thin- bedded, cherty limestone, commonly fossiliferous. Limestone may be silty or sandy in places. Thickness: 9 to 200 feet (3 to 61 m). Uses: Quarried at Hagersville, Cayuga, and Port Colborne for crushed stone. High cherty content makes much of the material unsuitable for concrete aggregate. Los Angeles Abrasion Test: 14-28% loss; Soundness Test: 4-10% loss; Absorption: 0.7-2.0%.

Dundee Formation (Middle Devonian)

Composition: Fine- to medium-crystalline, brownish grey, medium- to thick-bedded, dolomitic limestone with shaly partings, sandy layers, and chert in some areas. Thickness: 60 to 160 feet (18 to 49 m). Uses: Quarried near Port Dover and Pelee Island for crushed stone. Used at St. Marys as raw material for portland cement. Los Angeles Abrasion Test: 22-32% loss; Absorption: 0-4%.

Gull River Formation (Middle Ordovician)

Composition: Member A: thin- to thick-bedded, interbedded, grey argillaceous limestone and buff to green dolostone with a maximum thickness of 60 feet (18 m). Members B and C are dense, aphanitic limestones with argillaceous dolostone interbeds. Uses: Quarried at Kirkfield and Uhthoff for crushed stone. The product is generally fresh and compact with good cubic-shaped factor, low clay content, low absorption, and low soundness losses. Smooth particle surfaces may cause adhesion problems for asphalt. There is some alkali reactivity in a few of the layers.

Lockport and Amabel Formations (Middle Silurian)

Composition: Amabel Formation (Waterdown to the Bruce Peninsula): massive, fine-crystalline dolostone, with reef facies dolostone near Georgetown. Lockport Formation (lateral facies equivalent to the Amabel Formation from Waterdown to Niagara Falls): thin- to massive- bedded, fine-to medium-grained dolostone. Thickness: Amabel Formation: maximum observed

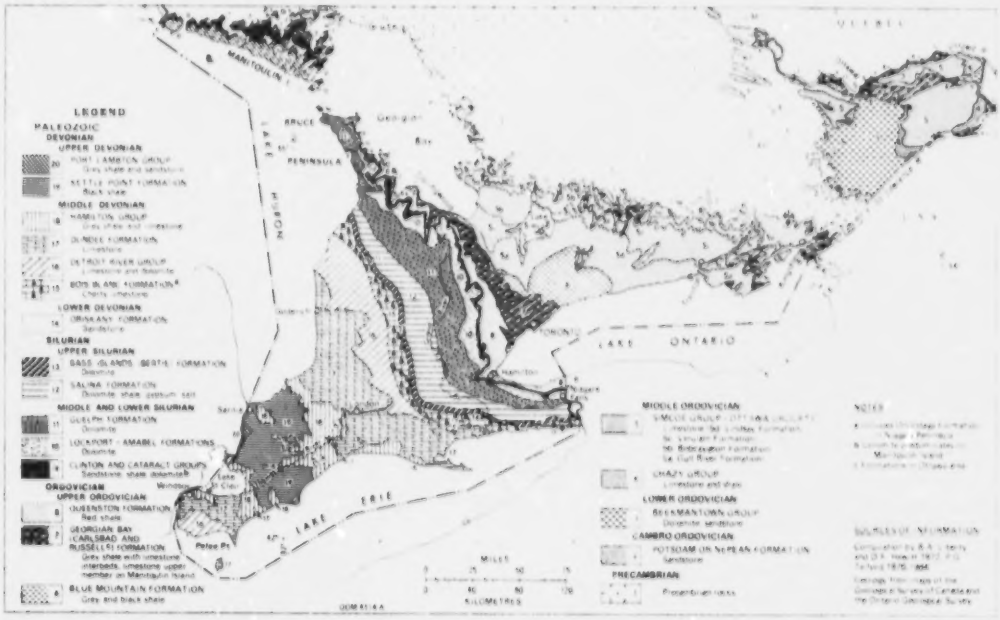


Figure 3. Bedrock Geology of Southern Ontario.

thickness of 84 feet (26 m). Lockport Formation: up to 130 feet (40 m). Uses: The Lockport and Amabel Formations have been used to produce lime, crushed stone, concrete aggregate and building stone throughout their area of occurrence, and are a resource of provincial significance. Los Angeles Abrasion Test: 21-35% loss; Soundness Test: 2.0% loss; Absorption: 0.4-1.6%.

Onondaga Formation (Middle Devonian)

(Equivalent to the Detroit River Group, with a textural change) Composition: Edgecliff Member: medium-bedded, fine- to medium- grained, dark grey cherty limestone with an estimated thickness of 25 to 30 feet (8 to 9 m). Clarence Member: massive-bedded, dark grey- brown, fine-grained, very cherty limestone having estimated thickness of 26 feet (8 m). Moorehouse Member: medium-bedded, dark grey-brown or purplish brown, fine- to coarse-grained, variably cherty limestone with an estimated thickness of 15 to 25 feet (5 to 8 m). Uses: Quarried for crushed stone on the Niagara Peninsula at Welland and Port Colborne. High cherty content makes much of the material unsuitable for concrete aggregate.

Ottawa Formation (Middle Ordovician)

Composition: Lower Phase (Lowville and Pamela Beds): shale, some sandstone and dolostone. Thickness: 100 feet (30 m). Middle Phase (Hull, Rockland, and Leray Beds): pure, thick-bedded, crystalline limestone. Thickness: 150 feet (46 m) near Ottawa. Upper Phase (Cobourg and Sherman Fall Beds): pure and impure crystalline limestone with few to numerous shaly partings, 450 to 475 feet (137 to 145 m) thick near Ottawa. Uses: The Leray, Rockland, and Hull Beds have been quarried extensively for crushed stone and for building stone. In addition, the Hull Beds are an excellent source of limestone for cement production and agricultural uses.

Oxford Formation (Lower Ordovician)

Composition: Medium- to thick-bedded, grey dolostone, with some shaly partings. Thickness: 240 feet (73 m). Uses: Quarried for crushed stone (road and concrete aggregate) at Ottawa, Brockville, and Smiths Falls.

BEDROCK SUITABLE FOR LIME PRODUCTION AND OTHER CHEMICAL USES

Detroit River Group (Middle Devonian)

(Equivalent to the Onondaga Formation in the Niagara Peninsula, with a textural change) Composition: Near Beachville, the group consists of medium- to micro-crystalline, medium-bedded, high-purity limestone. It grades northwards near St. Marys to soft, evenly bedded, fine-grained dolostone with bituminous laminae. Massive, porous, reef facies material also occurs to the north (Formosa Reef Limestone). Thickness: 100 feet (30 m) at Beachville, 350 feet (107 m) at Clinton. Uses: The most important source of high-purity limestone in Ontario is the Lucas Formation of the Detroit River Group at Beachville. Detroit River limestone produces much of Ontario's lime and cement. The Anderdon Member of the Lucas Formation is quarried at Amherstburg for crushed stone.

Grenville Marble (Precambrian)

Composition: Recrystallized fine- to coarse-grained white limestone and dolostone, usually of high chemical purity. Uses: Lime production, but also in small amounts for terrazzo chips, poultry grit, decorative stone, and building stone.

Guelph Formation (Middle Silurian)

Composition: Aphanitic to medium-crystalline, thick-bedded, soft, porous dolostone, characterized in places by extensive vuggy, porous reefal facies dolostone of high chemical purity. Thickness: 100 to 170 feet (30 to 52 m). Uses: The main use is for dolomitic lime in the construction industry. The formation is quarried near Hamilton and Guelph.

Lindsay Formation (Upper Ordovician)

Composition: fine-crystalline, rubbly, nodular-weathering limestone. Collingwood Member: organic-rich interbedded calcareous shales and limestones. Uses: Quarried at Picton, Ogden Point and Bowmanville for cement. The formation is generally unsuitable for crushed stone, concrete aggregate, or granular base course.

Verulam Formation (Middle Ordovician)

Composition: Fossiliferous, pure to argillaceous limestone and interbedded calcareous shale. The rock is not resistant to erosion and commonly weathers to rubble. Thickness: 200 to 300 feet (61 to 91 m). Uses: Quarried at Picton, Ogden Point, and Mara Township for use in cement manufacture. The formation is unsuitable for crushed stone because of clay impurities, many clayey interbeds, and low abrasion resistance, high soundness losses and poor freeze and thaw resistance.

BEDROCK SUITABLE FOR BRICK AND TILE MANUFACTURE

Georgian Bay Formation (Upper Ordovician) (Formerly known as the Meaford-Dundas and Blue Mountain shales in the Toronto and Bruce Peninsula areas) Composition: Soft, fissile, blue-grey shale with limey or sandy lenses in a few places. Thickness: 640 feet (195 m) at Toronto. Uses: Several producers in the vicinity of Metro Toronto produce brick and structural tile. Lightweight aggregate has been produced at Streetsville by heat expansion of the shale.

Hamilton Group (Middle Devonian)

Composition: Grey shale with interbeds of crystalline and cherty limestone. The group has six formations, but only the Arkona Formation is of commercial value. It is a soft, light grey, calcareous shale which is plastic and easily worked when wet. Thickness: 80 to 300 feet (24 to 91 m). The Arkona Formation has a thickness of 14 to 121 feet (4 to 37 m). Uses: The Arkona Formation is extracted at Thedford and near Arkona for production of drainage tile.

Queenston Formation (Upper Ordovician)

Composition: Red, thin- to thick-bedded, sandy to argillaceous shale with green mottling and banding. Thickness: 400 to 500 feet (122 to 152 m). Uses: There are several large shale quarries developed in the Queenston Formation in the Toronto-Hamilton region and one at Russell, near Ottawa. All produce brick for construction. The Queenston Formation is the most important source material for brick manufacture in the Province.

BEDROCK SUITABLE FOR OTHER INDUSTRIAL PRODUCTS

Nepean (Potsdam) Formation (Cambro-Ordovician)

Composition: Creamy, coarse-grained, silica sandstone. Uses: Quarried throughout its area of outcrop for building stone, decorative stone, abrasives, and for glass making.

Salina Formation (Upper Silurian)

Composition: Grey and red shale, brown dolomite, and, in places, salt, anhydrite, and gypsum. The formation consists predominantly of evaporite deposits with up to eight members identified. Uses: Gypsum is mined at Hagersville, Caledonia, and Drumbo. Salt is mined at Goderich and is produced from brine wells at Amherstburg, Windsor, and Sarnia.

Blue Mountain Formation (Upper Ordovician)

(Formerly known as the Whitby Formation) Composition: Blue-grey, predominantly non-calcareous shale. Uses: Quarried at Bowmanville for use in cement production.

LEGEND

(Continued from right margin)

DY-TH-2 — Test hole location; identification number.

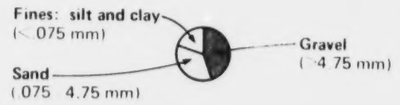
6 / 24G — Selected water well location. Layers of materials are described by: reported thickness of material (in feet); reported type of material (number only - overburden, G - gravel, S - sand, C - clay, T - till, B - boulders, Bk - bedrock).

G 1 | IC / C-O — Deposit symbol; see below.

Texture symbol, see below; see Figures 2a & 2b.

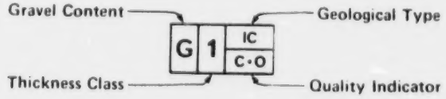
DY-GT-2 — Geophysical traverse line. Identification number.

TEXTURE SYMBOL



The Texture Symbol provides quantitative assessment of the grain size distribution at a sampled location. The relative amounts of gravel, sand, silt and clay in the sampled material are shown graphically by the subdivision of a circle into proportional segments. The above example shows a hypothetical sample consisting of 45% gravel, 35% sand and 20% silt and clay.

DEPOSIT SYMBOL



Deposits are identified by Gravel Content, Thickness Class, Geological Type and Quality Indicator. Gravel Content is expressed as a percentage of gravel-sized material (i.e. material retained on the 4.75 mm sieve). Thickness Class is based on potential aggregate tonnage per acre. Geological Type refers to geologic origin. Quality Indicator describes objectionable grain size and lithology.

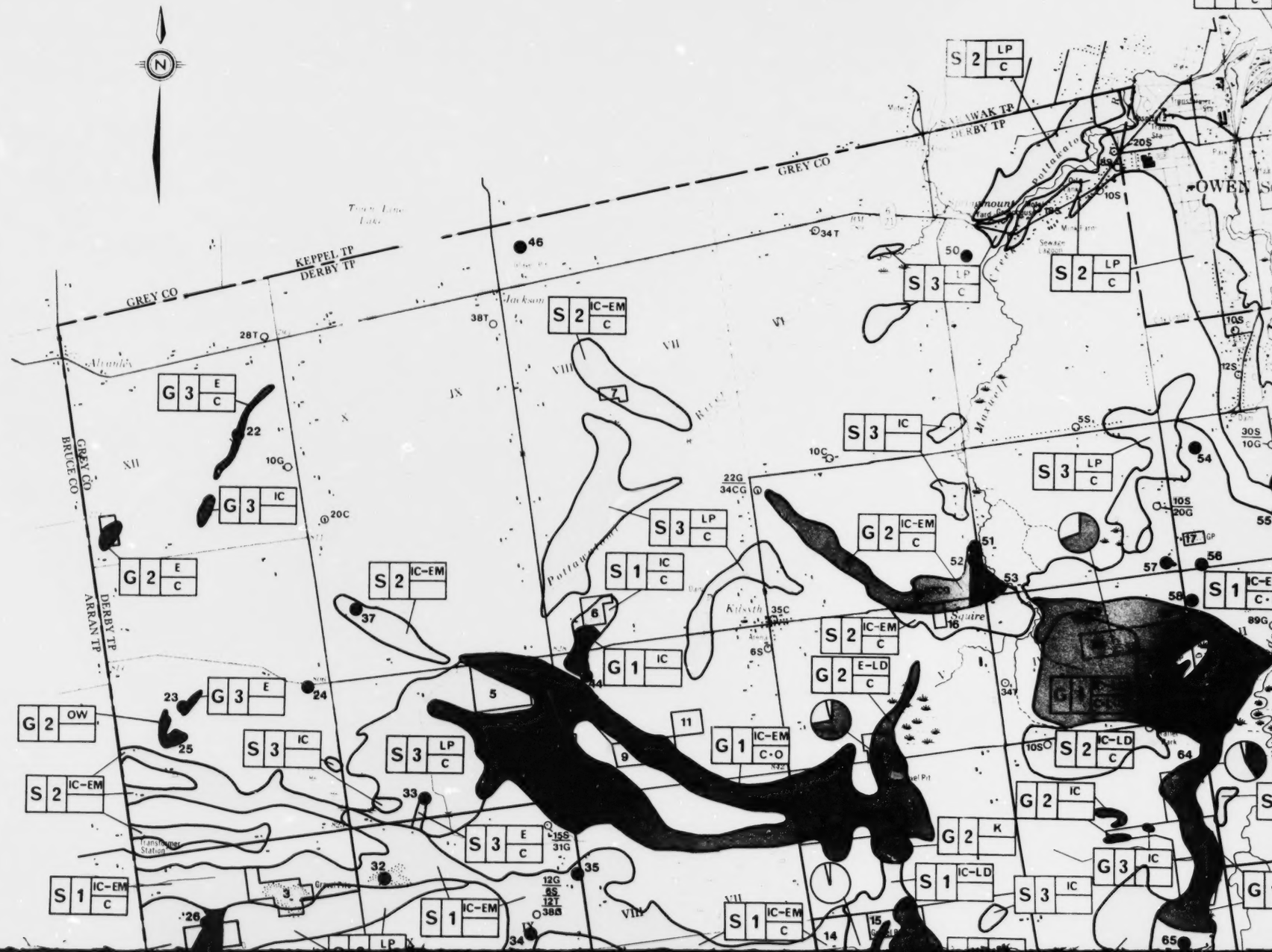
Gravel Content

G	Greater than 35% gravel.
S	Less than 35% gravel.

Thickness Class

Class	Average Thickness in Feet (Metres)	Tons per Acre	Tonnes per Hectare
1	greater than 20 (>6)	greater than 50,000	greater than 112 000
2	10 - 20 (3 - 6)	25,000 - 50,000	56 000 - 112 000
3	5 - 10 (1.5 - 3)	12,500 - 25,000	28 000 - 56 000
4	less than 5 (<1.5)	less than 12,500	less than 28 000

Geological Type



Ontario

Ministry of Natural Resources

Hon. Michael Harris
Minister

Mary Mogford
Deputy Minister

ONTARIO GEOLOGICAL SURVEY

AGGREGATE RESOURCES INVENTORY

DERBY TOWNSHIP

GREY COUNTY

MAP 1
DISTRIBUTION OF SAND AND GRAVEL DEPOSITS

Scale 1 : 50 000

Mile 1 0 1 Mile

Metres 1000 0 1 Kilometre

NTS Reference: 41 A/6, 41 A/7
41 A/10, 41 A/11

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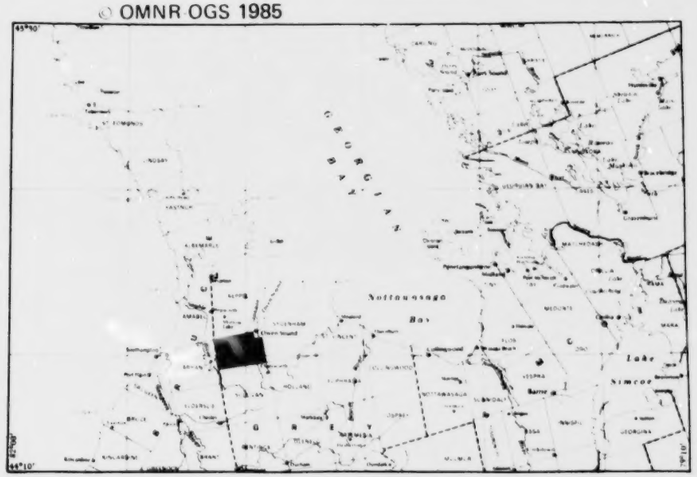


LEGEND

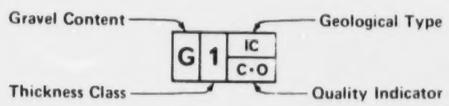
(Some map units and symbols may not apply to this map.)

MAP UNITS

- Gravel deposit.
- Sand deposit.
- Gravel overlain by other surficial material.

circle into proportional segments. The above example shows a hypothetical sample consisting of 45% gravel, 35% sand and 20% silt and clay.

DEPOSIT SYMBOL



Deposits are identified by Gravel Content, Thickness Class, Geological Type and Quality Indicator. Gravel Content is expressed as a percentage of gravel-sized material (i.e. material retained on the 4.75 mm sieve). Thickness Class is based on potential aggregate tonnage per acre. Geological Type refers to geologic origin. Quality Indicator describes objectionable grain size and lithology.

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S	Less than 35% gravel.

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Class	Average Thickness in Feet (Metres)	Tons per Acre	Tonnes per Hectare
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2	10 - 20 (3 - 6)	25,000 - 50,000	56 000 - 112 000
3	5 - 10 (1.5 - 3)	12,500 - 25,000	28 000 - 56 000
4	less than 5 (<1.5)	less than 12,500	less than 28 000

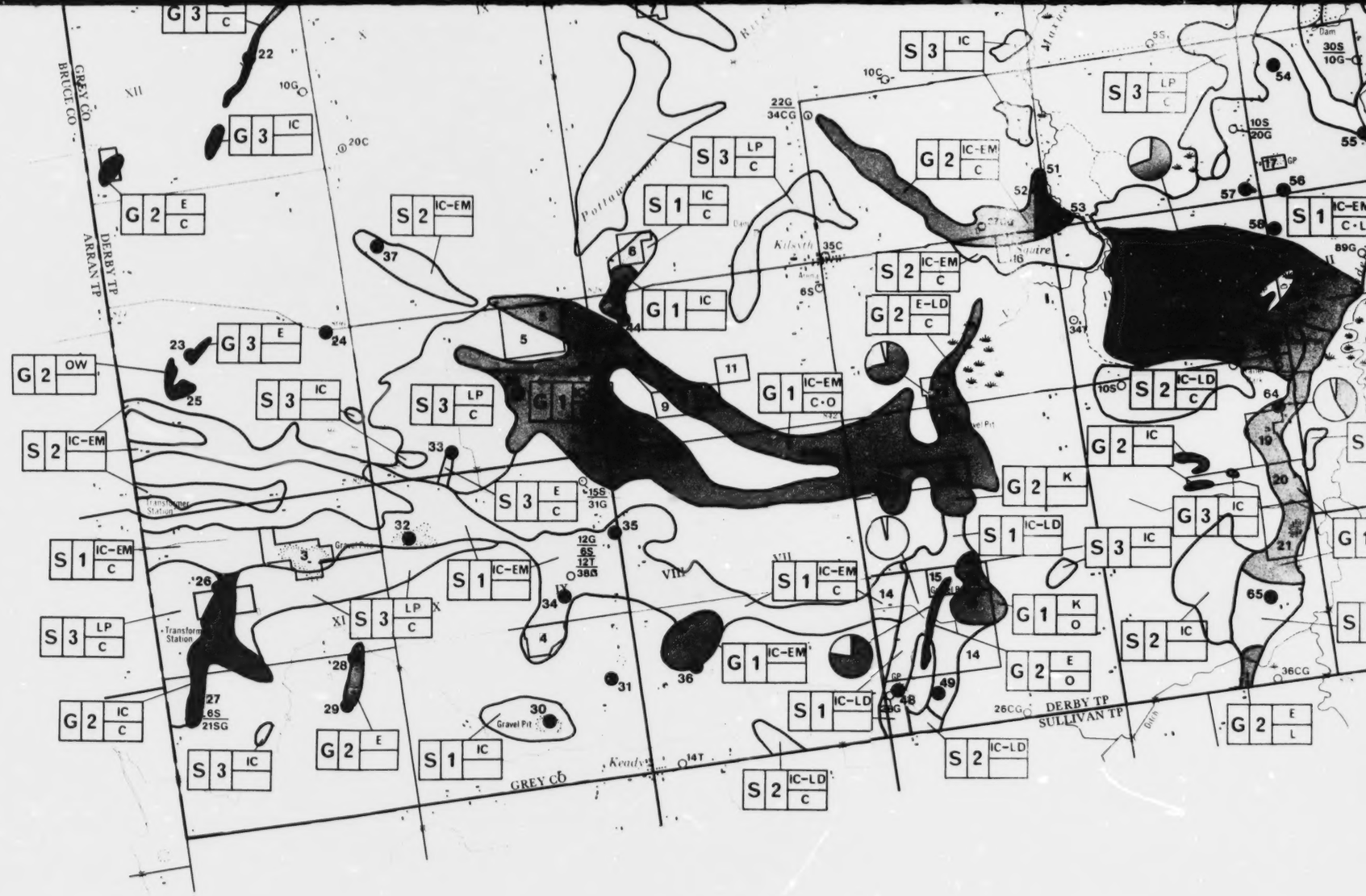
Geological Type

AL	Older Alluvium	**K**	Kame
E	Esker	**LB**	Lacustrine Beach
EM	End Moraine	**LD**	Lacustrine Delta
IC	Undifferentiated Ice-Contact Stratified Drift	**LP**	Lacustrine Plain
		OW	Outwash
ICT	Ice-Contact Terrace	**WD**	Windblown Forms

(see Appendix C for descriptions of Geological Types)

Quality Indicator

	If blank, no known limitations present.
C	Clay and/or silt (fines) present in objectionable quantities.
L	Deleterious lithologies present.
O	Oversize particles or fragments present in objectionable quantities.



SOURCES OF INFORMATION

Base map by Surveys and Mapping Branch, Ontario Ministry of Natural Resources.
Licence data from District and Regional Offices, Ontario Ministry of Natural Resources.
Aggregate suitability data from the Engineering Materials Office, Ontario Ministry of Transportation and Communications.
Test hole data from Aggregate Assessment Office, Ontario Geological Survey, Ontario Ministry of Natural Resources.
Selected drilled water well data from the Ontario Ministry of the Environment.
Drilling data from the Petroleum Resources Section, Ontario Ministry of Natural Resources.

Geology by: B. H. Feenstra, in prep.
W. J. Leyland, 1979.
D. R. Sharpe and W. A. D. Edwards, 1979.
D. R. Sharpe and G. R. Jamieson, 1982.

Additional Field Work by: Staff of the Aggregate Assessment Office.

Compilation and Drafting by: Staff of the Aggregate Assessment Office.

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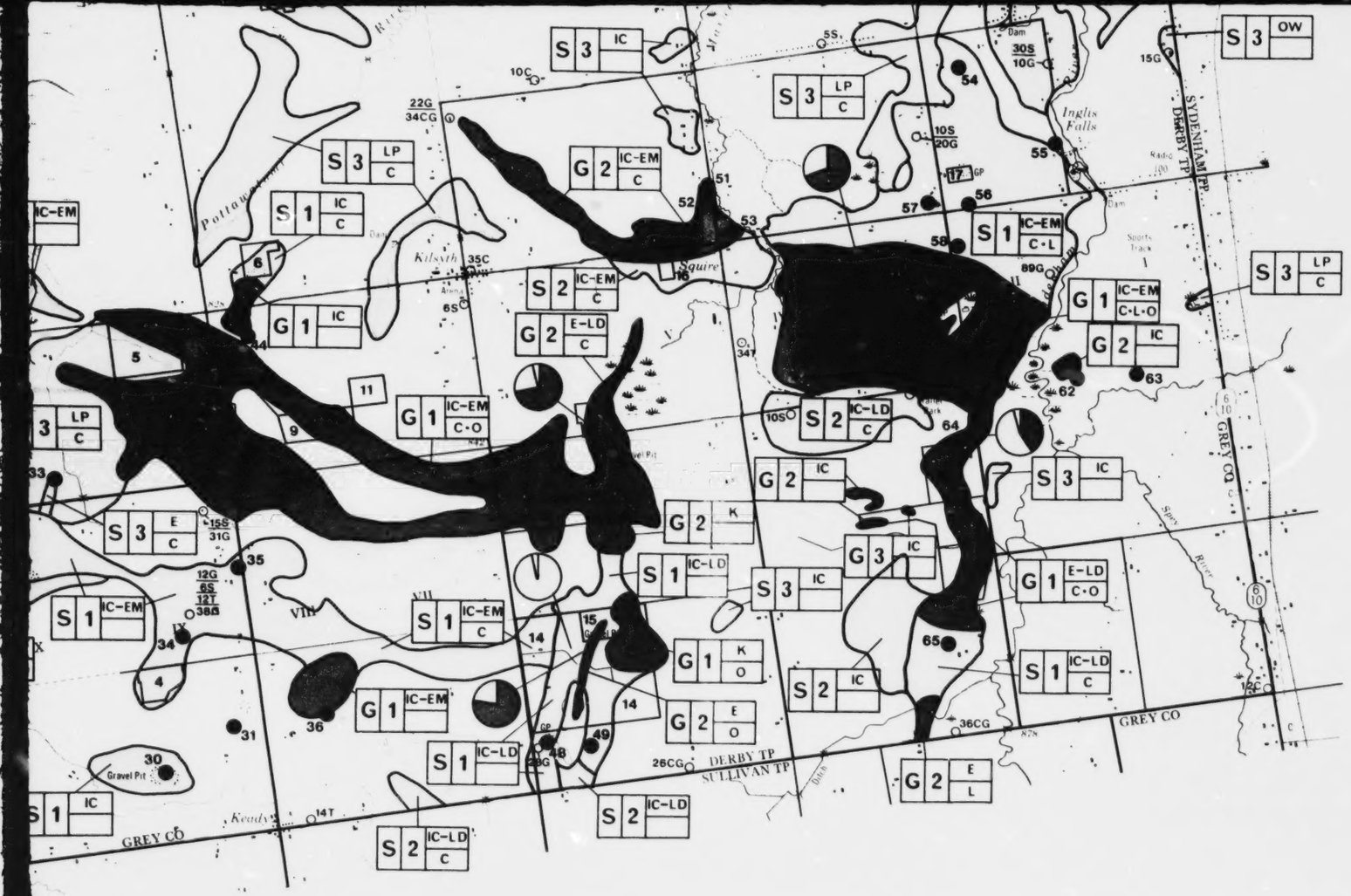
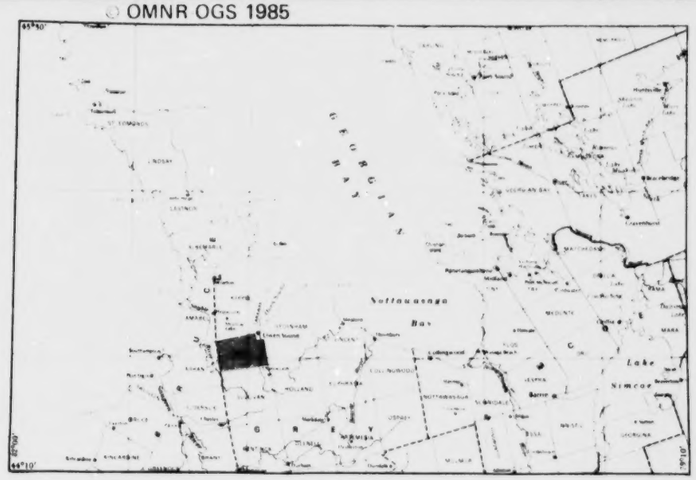
Issued 1985.

Information quoted for an individual test hole or pit refers to a specific sample or face. Care should be exercised in extrapolating such information to other parts of the deposit.





LEGEND

(Some map units and symbols may not apply to this map.)

MAP UNITS

- Gravel deposit.
- Sand deposit.
- Gravel overlain by other surficial material.
- Sand overlain by other surficial material.
- Other surficial deposits or exposed bedrock.

SYMBOLS

- Geological and aggregate thickness boundary of sand and gravel deposits.
- Municipal boundary.
- 2 — Licenced property boundary; Property number: see Table 2.
- ● 3 — Unlicenced sand or gravel pit*; Property number: see Table 2.
  *Abandoned pit or wayside pit operating on demand under authority of a permit.

(continued at left margin)

SOURCES OF INFORMATION

and Mapping Branch, Ontario Ministry of Natural Re-

rict and Regional Offices, Ontario Ministry of Natural

ata from the Engineering Materials Office, Ontario tation and Communications.

gregate Assessment Office, Ontario Geological Survey, Natural Resources.

vell data from the Ontario Ministry of the Environment.

Petroleum Resources Section, Ontario Ministry of

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Ontario

ONTARIO

AGGREGA

DER

SELECTE
RE

Mile 1
Metres 100

NTS

© OMNR OGS 1

MAP UNITS

1

SYMBOLS

Ministry of Natural Resources

Ontario

Hon. Michael Harris
Minister

Mary Mogford
Deputy Minister

ONTARIO GEOLOGICAL SURVEY

AGGREGATE RESOURCES INVENTORY

DERBY TOWNSHIP

GREY COUNTY

MAP 2
SELECTED SAND AND GRAVEL RESOURCE AREAS

Scale 1: 50 000

Mile 1 0 1 Mile

Metres 1000 0 1 Kilometre

NTS Reference: 41 A/6, 41 A/7
41 A/10, 41 A/11

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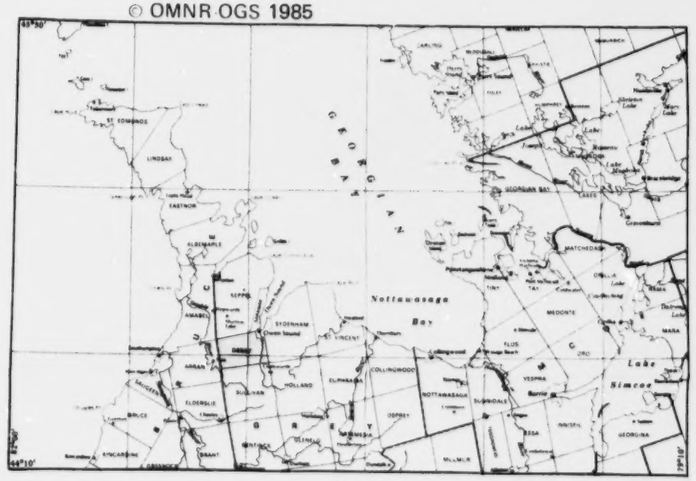

LEGEND

MAP UNITS

(1) Selected sand and gravel resource area, primary significance; deposit number; see Table 3.

Selected sand and gravel resource area, secondary significance.

Selected sand and gravel resource area, tertiary significance.

SYMBOLS

1a
1b
1c
2a
2b
2c
2d
3
Gravel Pit
Cemetery
Inglis Falls
Keady
Sligo
Square
Bath
Ontario
Metres 1000
NTS R
OMNR OGS 198
MAP UNITS
SYMBOLS
SOUR
Licence data from District
Resources.
Base map by Survey and
sources.
Aggregate suitability data
Ministry of Transportat
Geology by B. H. Feenstra
W. J. Leyland
D. R. Sharpe
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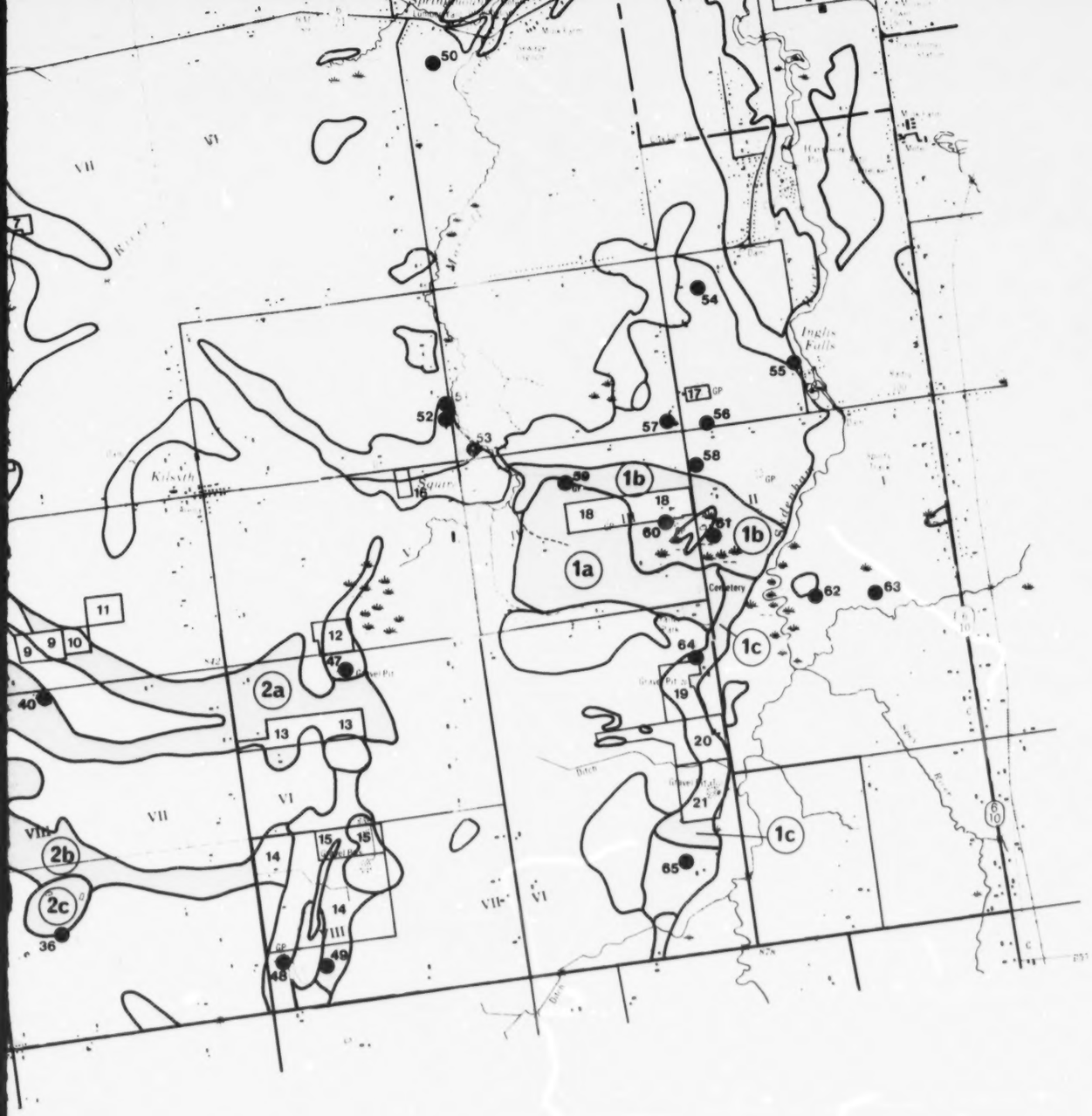

1a
1b
1c
2a
2b
2c
1b
1c
1c
Cemetery
Inglis Falls
Kilsyth
Square
Gravel Pit
Gravel Pit
Gravel Pit
Dam
Dam
Dam

LEGEND

(Continued from right margin)

DRIFT THICKNESS

Bedrock outcrop (see Table 4); areas of exposed bedrock partially covered by a thin veneer of drift. Drift thickness is generally less than 3 feet (1 m).

Bedrock covered by drift (see Table 4); drift thickness is generally 3 to 25 feet (1 to 8 m). Bedrock outcrops may occur.

Bedrock covered by drift (see Table 4); drift thickness is generally 25 to 50 feet (8 to 15 m). Isolated bedrock outcrops may occur.

Bedrock covered by drift; drift thickness is generally greater than 50 feet (15 m).

SYMBOLS

(1) Selected bedrock resource area; deposit number; see Table 6.

Geological formation boundary.

Geological formation member boundary.

Formation thickness boundary (see text).

25 Drift thickness contour. (3-foot, 25 foot and 50 foot contours are shown).

Municipal boundary.

Q2 Licenced quarry boundary; Property number: see Table 5.

Q3 Unlicenced quarry*; Property number: see Table 5. *Abandoned quarry or wayside quarry operating on demand under authority of a permit.

x Isolated bedrock outcrop.

24 Selected water well location; reported depth to bedrock (in feet).

SOURCES OF INFORMATION

Base map by Surveys and Mapping Branch, Ontario Ministry of Natural Resources.

Licence data from District and Regional Offices, Ontario Ministry of Natural Resources.

Aggregate suitability data from the Engineering Materials Office, Ontario Ministry of Transportation and Communications.

Selected water well data from the Ontario Ministry of the Environment.

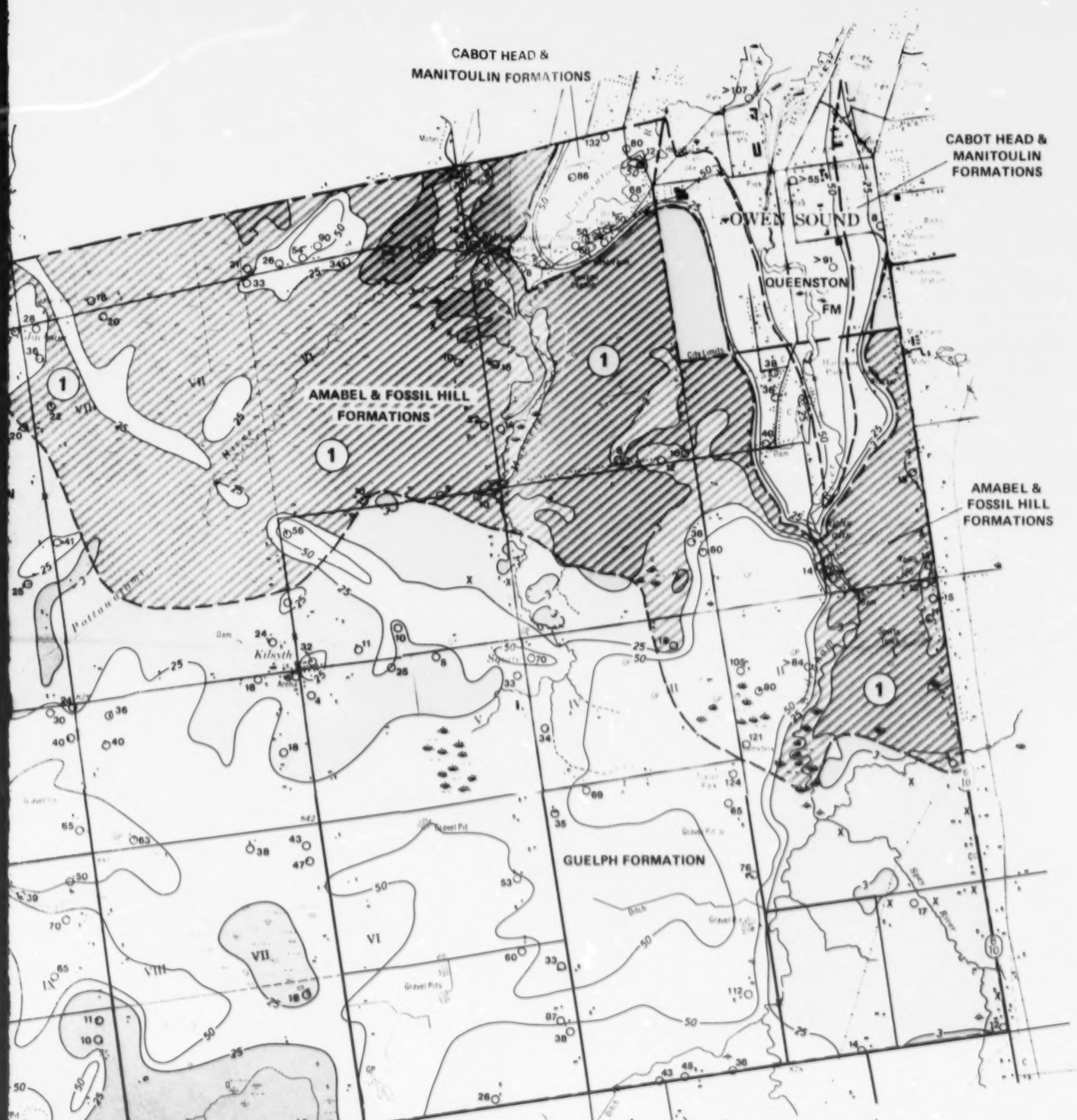
Drilling data from the Petroleum Resources Section, Ontario Ministry of Natural Resources.

Geology by: B. H. Feenstra, in prep.
B. A. Liberty, 1966.
D. R. Sharpe, 1982.
D. R. Sharpe, et al., 1979.

Additional Field Work by: Staff of the Aggregate Assessment Office.

Compilation and Drafting by: Staff of the Aggregate Assessment Office.

This map is to accompany O.G.S. Aggregate Resources Inventory Paper 112.



Ministry of Natural Resources

Ontario

Hon. Michael Harris
Minister

Mary Mogford
Deputy Minister

ONTARIO GEOLOGICAL SURVEY

AGGREGATE RESOURCES INVENTORY

DERBY TOWNSHIP

GREY COUNTY

MAP 3
BEDROCK RESOURCES

Scale 1: 50 000

Mile 1 0 1 Mile

Metres 1000 0 1 Kilometre

NTS Reference: 41 A/6, 41 A/7
41 A/10, 41 A/11

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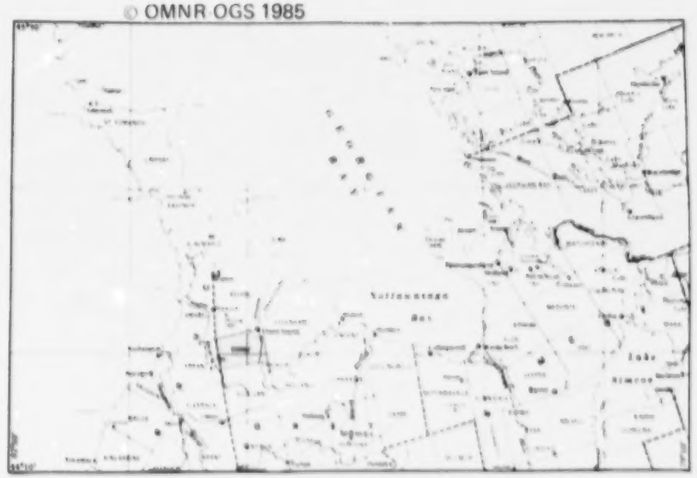

LEGEND

(Some units and symbols may not apply to this map.)

BEDROCK UNITS

PALEOZOIC

SILURIAN

MIDDLE and **LOWER SILURIAN**

GUELPH FORMATION
Dolostone

AMABEL FORMATION
Dolostone

FOSSIL HILL FORMATION
Dolostone

CABOT HEAD FORMATION

Bedrock covered by drift (see Table 4); drift thickness is generally 25 to 50 feet (8 to 15 m). Isolated bedrock outcrops may occur.

Bedrock covered by drift; drift thickness is generally greater than 50 feet (15 m).

SYMBOLS

(1) Selected bedrock resource area; deposit number, see Table 6.

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Geological formation member boundary.

Formation thickness boundary (see text).

25 Drift thickness contour. (3-foot, 25 foot and 50 foot contours are shown).

Municipal boundary.

Q2 Licenced quarry boundary. Property number see Table 5.

● Q3 Unlicenced quarry.* Property number see Table 5. *Abandoned quarry or wayside quarry operating on demand under authority of a permit.

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○ 24 Selected water well location; reported depth to bedrock (in feet).

SOURCES OF INFORMATION

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Additional Field Work by: Staff of the Aggregate Assessment Office.

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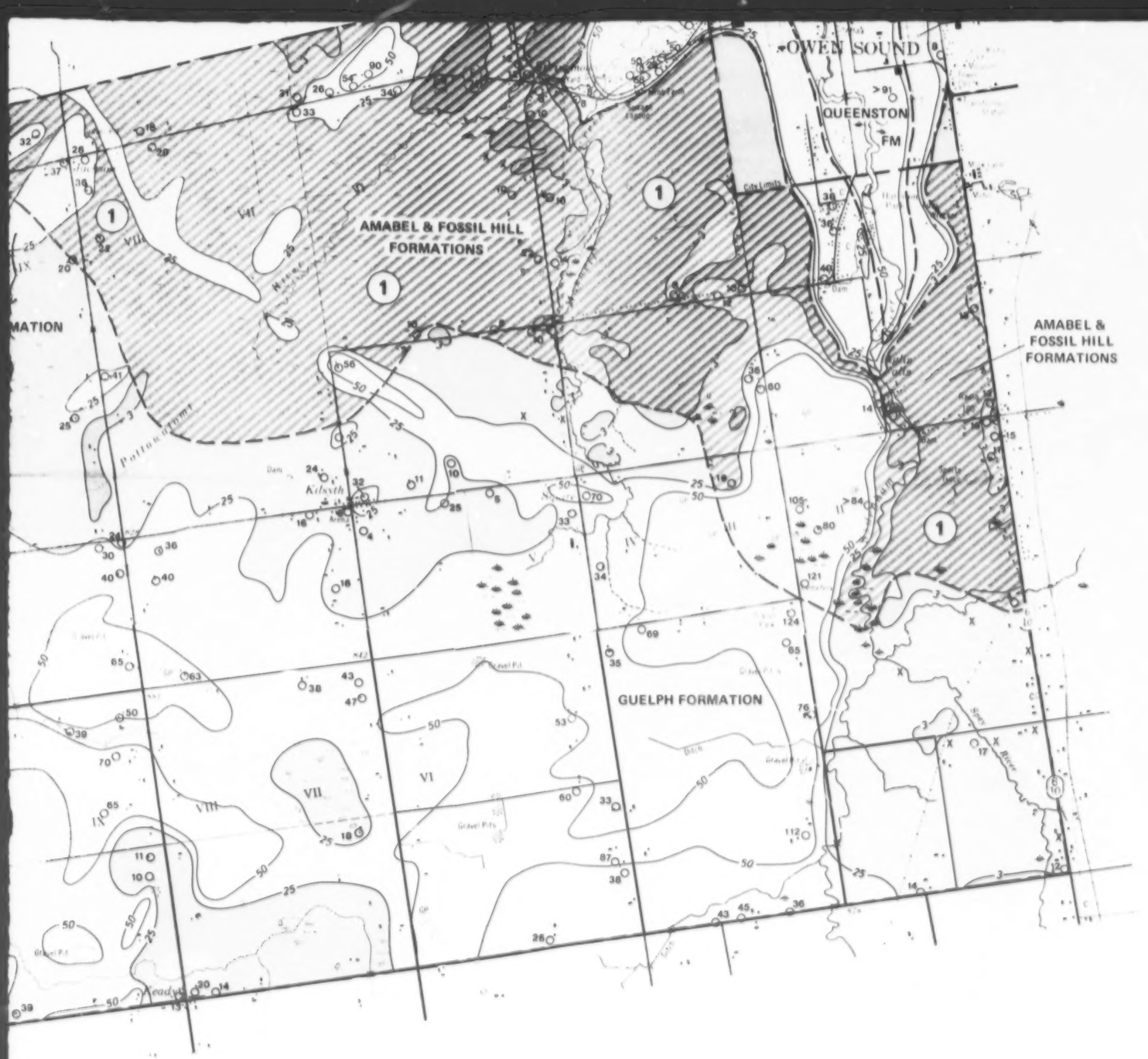
This map is published with the permission of V. G. Milne, Director, Ontario Geological Survey.
Issued 1985.



DERBY

DERBY TOWNSHIP

GREY COUNTY

MAP 3
BEDROCK RESOURCES

Scale 1 : 50 000

Mile 1 0 1 Mile

Metres 1000 0 1 Kilometre

NTS Reference: 41 A/6, 41 A/7
41 A/10, 41 A/11

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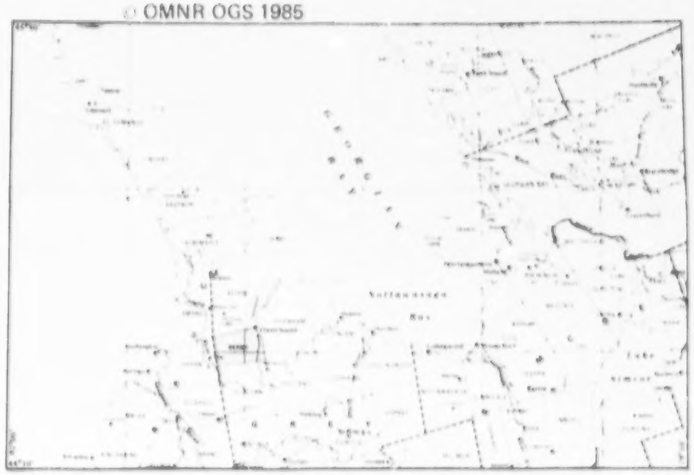

LEGEND

(Some units and symbols may not apply to this map.)

BEDROCK UNITS

PALEOZOIC

SILURIAN

MIDDLE and LOWER SILURIAN

GUELPH FORMATION
Dolostone

AMABEL FORMATION
Dolostone

FOSSIL HILL FORMATION
Dolostone

CABOT HEAD FORMATION
Shale

MANITOULIN FORMATION
Dolostone

ORDOVICIAN

UPPER ORDOVICIAN

QUEENSTON FORMATION
Red shale

(continued at left margin)